CHEMICAL & METALLURGICAL ENGINEERING

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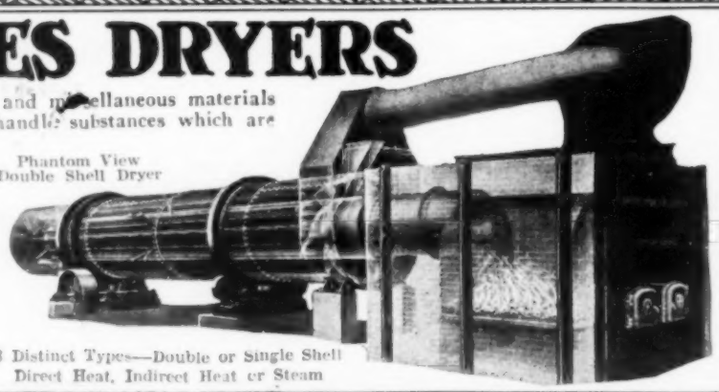

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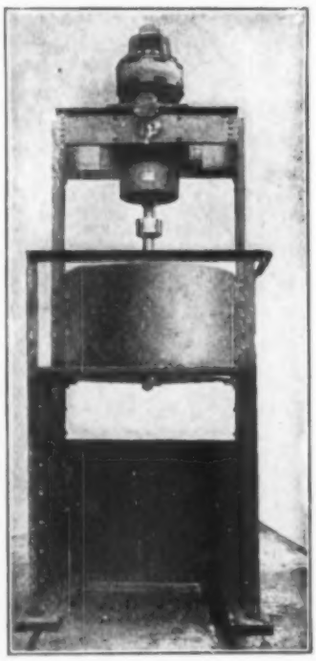

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Index to the Current Volume

FOLLOWING the custom established by this journal beginning with vol. 1, there is bound in this issue the current index. A special effort has been made to produce an index that would be exceptionally useful. It has not been compiled in a hasty or careless manner, but according to a well-defined plan worked out by the editorial staff, with a special view to the reader's interests.

It seems appropriate at this time to say a word in regard to the proposed 20-volume index to CHEMICAL & METALLURGICAL ENGINEERING regarding which we circularized our subscribers last fall. The response was so favorable that we planned to prepare the index, but have been deterred in so doing on account of the shortage of paper and the greatly increased mechanical cost of production. These conditions were not foreseen when the index was proposed, but they necessitate abandoning the project for the time being.

A Question of Professional Ethics

CODES of ethics have been drawn from time to time and proposed for adoption by various bodies of professional men. In their essence such codes must be broad and general, leaving to the individual the nicety of interpretation in particular cases. When the test comes we discover not so much the efficiency or deficiency of the code as the integrity of the man; and after all that is the crux of the whole matter whether we have codes or not. Of course codes are helpful even to men of good intentions, just as padlocks are discouraging to those of evil design, and it is just as well for men of high ideals to formulate a statement of what they believe to be good conduct for themselves and others. So we have no quarrel with codes, though we admire ethical conduct the more where no code is written.

A recent case in point is the action of THEODORE J. HOOVER in offering to submit in evidence in the flotation litigation between Minerals Separation, Ltd., and the Miami Copper Co. a document which came into his possession when he was general manager of Minerals Separation in 1907. The document in question is a copy of "The Theory of Concentration Processes Involving Surface Tension," by HENRY L. SULMAN and HUGH F. K. PICARD, consulting metallurgists to Minerals Separation then and now. When written, it purported to be a full and complete treatise on the subject, embodying the authors' ideas on the science and technology of the flotation process, and it is the same document to which we referred in our issue of March 3, 1920, when we commented on the discrepancy between the ideas held by Minerals Separation in 1907 and those advanced by Mr. SULMAN in his gold-medal paper before the Institution of Mining and Metallurgy in 1920. The document was given by Mr. SULMAN to Mr. HOOVER in 1907, and subsequently remained in his possession for more than twelve years without request for its return. In the meantime Mr. HOOVER severed his connection with Minerals Separation and has not been in its employ since 1910.

Such was the status when in 1919 Mr. HOOVER had occasion to delve into the record of the case of Minerals Separation, Ltd. vs. Miami Copper Co. From his affidavit on the subject we learn that as a consequence of his investigation he was convinced "that the present contentions of the complainant therein as to the scope of United States Patent No. 835,120 are so entirely opposed to the statement of two of the patentees as contained in the treatise, above referred to, as to amount, in my opinion, to an attempt to perpetrate a fraud on the court and to impose an unwarranted and unjustifiable burden upon the mining industry of the country."

With regard to the state of the art prior to the date of application for Patent No. 835,120, Mr. HOOVER says that the ideas of SULMAN and PICARD as given in the treatise are "wholly inconsistent with the position for which their assignee, Minerals Separation, Ltd., is now contending in this case."

With this as a background, we may ponder the delicate position in which Mr. HOOVER found himself. As a former employee, at one time under contract with Minerals Separation, he legitimately came into possession of documentary evidence of the avowed opinions of that company's metallurgists as to the scientific basis of the flotation process. Twelve years later, as a private engineer and professor of mining and metallurgy in Stanford University, he finds his former employers engaged in litigation, basing their contentions as to the prior state of the art on statements wholly inconsistent with those given in the treatise mentioned. What was Mr. HOOVER to do? Had he any duty at all in the matter? If so, what was it and to whom? Was his possession of the treatise a matter of confidence which he was bound to keep inviolate? Had he any obligation to Minerals Separation under his former contract of employment? Was it his duty to speak or keep silent on the subject?

We can imagine the soul-searching effort to find the proper answer to these and other questions, because the decision when made would be fraught with important consequences. If Mr. HOOVER remained silent and allowed Minerals Separation ultimately "to perpetrate a fraud on the court and to impose an unwarranted and unjustifiable burden upon the mining industry of the country," he might be considered accessory before the fact. On the other hand if he opposed the claims of

his former employers they might brand him as treacherous and disloyal, and seek to discredit him in various ways. The path of duty finally led Mr. HOOVER to an exposure of the facts as set forth in his affidavit. But the determining motive to which we want to direct attention is that he was moved to break silence, as he testifies, "particularly as I believe that the rights of the public are also involved."

Evidently Mr. HOOVER'S sense of duty to the public transcended all other considerations, and few will question the soundness of his decision. For ourselves we are glad to see so important a question resolved as a matter of ethics free from technicality.

Just a Little Strike

ON THE 18th of this month the switchmen and yard employees of the railways in Baltimore expressed by a strike their impatience over what they regarded as dilatoriness on the part of the authorities charged with the problem of finding a satisfactory readjustment of their wage scale; that is, a scale that the railways could meet on the one hand, and which would be acceptable to them on the other. The strike, as some labor leaders are constantly telling us, is their only weapon and their only means of expression. Since neither sword nor gun nor any other weapon is necessary to register impatience, the present walk-out must be regarded as an expression of opinion rather than as a blow, so far as its intent is concerned. The gentlemen were annoyed and this is the way in which they tell it. At present writing the strike has extended through the Philadelphia district and reached Jersey City.

Now let us see what this expression of opinion costs. Baltimore is headquarters for the manufacture of tin cans in the Eastern district. The factories are there. The corn and tomato crops of Delaware, Maryland and New Jersey are ripening. There is no reserve tin plate in existence. It cannot be made unless the steel is transported into the works and the cans transported away to the canneries. Nevertheless the crops are ripening, and no cans are being made or delivered in this region. Therefore most of the corn and tomato crop in the states mentioned will have to rot if the strike continues. There's no market for this immense amount of perishable goods now. They are needed for our winter food supply. Of course it may be said that tomatoes are 90 per cent water, and that we can get water from the pump, but tomatoes contain vitamines and they make other foods edible which otherwise are not. Canned corn and tomatoes are necessaries.

There's an immense crop of sweet corn in Maine, and this also is chiefly dependent upon Baltimore cans. A few cans may come in from Rochester, N. Y., if the strike does not extend out there, but only a small fraction of those needed. And a very few may be drawn from Portland, but not enough to count. The farmers—poor Rubes!—didn't know the yardman mind or the switchman conscience. They planted up to the limit, and now the joke is on them. Then next winter the joke will be on us. There is some danger, however, that the great American sense of humor will fail us all by the time cold weather comes around.

Out in Newcastle, Pa., there are two tin-plate mills and a Carnegie steel plant. They were shut down from April 10 to June 7 for lack of coal. And the plate mills couldn't get steel; all because of transportation difficulties due to strikes. These strikes also were expressions of opinion. The immediate result was that five to six thousand men were thrown out of work. They have sold their Liberty bonds, used credit to the limit at the groceries, and are in arrears for rent. It takes a lot to support a family for two months at present prices. Now the mills have started up and the men are working, but the situation is delicate. Freight moves very slowly and at any fresh disturbance they must close down again.

The connection between steel mills and tin-plate mills and can factories and canneries is a kind of frayed-out shoestring. Transportation is needed and there is hardly any transportation of freight. It is too late now to make up all the cans needed. In Indiana there are 5,500 acres planted in tomatoes that face nearly a total loss. Wisconsin has 60,000 acres planted in peas. The seed cost $9 a bushel and it takes three and one-half bushels to the acre. That means an investment of nearly $2,000,000 by Wisconsin farmers for seed alone. If they are able to can half the crop owing to some early deliveries of cans, they will be lucky. The rest is in the lap of fate as may be determined by the meditations and opinions of the railroad employees.

Sardines are beginning to run along the Maine coast, but there are no cans at hand. And there's no use in catching them if they can't be packed. Fish do not keep well if exposed to the air.

In other words, the gentlemen engaged in switching cars are annoyed. They register their annoyance by their "only weapon," the strike, and this in turn causes the rich products of our blessed land to rot in the fields, it bankrupts farmers, and dooms hundreds of thousands of our people to hunger and millions to distress. If any king of the past two hundred years were to have inflicted such a punishment as a mark of his disapproval he would have been dethroned. People will not stand that sort of thing from kings. But we seem to endure it with complacency from yardmen and switch-tenders. Perhaps their hearts bleed for the suffering in prospect.

The Stable Market For Chilean Nitrate

VARIOUS sources of information, notable among which are the United States Department of Agriculture and the Chilean Nitrate Committee, show that the demand for Chilean saltpeter in the world market has been the criterion of the nitrogen requirements for explosives and fertilizers for a number of years past. This is not an amazing fact when we consider that the industry dates back to the discovery of caliche by the early Indian tribes of Tarapaca, that sodium nitrate was known in the time of PHILIP V and that actual production of saltpeter began in Huantajaya during the early part of the eighteenth century. Tradition has it that when the Indians revealed their discovery to the priest he announced that the explosive soil was not the abode of an evil spirit but a gift of Providence for increasing the productiveness of the earth. Thus it was simultaneously found to be both an explosive and a fertilizer.

Wise, in truth, are the present-day dealers in this old-established commodity who philosophically accept the advent of new processes for securing nitrogen compounds. In spite of the upheaval of the market due to

the war the business is even now showing signs of future stability. The development of better methods for supplying the wants of mankind should always be welcomed if for no other reason than the consequent addition to individual wealth.

Experience with the marked industrial improvements of the past hundred years has taught us that such processes of growth are more often evolutionary than revolutionary. This is easily accounted for in that economic laws essentially function to keep pace with the new achievements and with small disturbance to industrial welfare. Nitrogen-fixation plants will supply the consumer with new compounds of nitrogen, but the demand is growing at such a rate as to still require an increasing output of the product from the deserts of Chile.

The most fundamental change which will likely take place in the Chilean nitrate industry is the forced application of modern methods to mining and leaching operations. Competition which necessitates improvements over aboriginal processes is wholesome indeed.

Organizing the Steel Workers

FAR from the failure of the iron and steel strike of last autumn having settled the matter of whether or not the iron and steel industry should be "organized," the present situation is that there is competition in the matter of endeavoring to do the job. The work of organizing that led to the recent strike was conducted more or less under the auspices of the American Federation of Labor. There is an organization about forty years old, called the Amalgamated Association, for several years "affiliated" with the Federation, which aspires to do all the organizing there is to be done in the industry, and wanted the Federation to leave the matter to it, but the Federation at the annual convention in Montreal turned down the proposition and laid plans for a fresh campaign of its own. The old committee, which survived after the Fitzpatrick and Foster resignations, following the failure of the strike, is to be disbanded and an entirely new committee formed, profiting by the mistakes the last time.

The Amalgamated Association has been losing ground more or less continuously, except during the late war, since its Homestead strike of 1892, and of late has controlled practically nothing except 30 or 40 per cent of the hot-mill labor at the sheet and tin-plate mills, the tin-house labor at the same tin-plate mills, and most of the iron mills from Pittsburgh west. One advantage it had to offer to those signing its scales was that the matter was over for a year, and the management had to deal with a mill committee instead of with individuals. The scale agreement prevented a strike as long as its terms were complied with. Last fall the Amalgamated Association was commended for keeping its men at work, under its signed scales. Instead of being encouraged to continue the system the Amalgamated Association proposed to the sheet and tin-plate manufacturers hitherto signing the scale that for the new year, beginning July 1, the men for whom the scale was signed should have the right to go on strike if the Amalgamated Association should at any time organize other departments operated by the company signing the scale, and the scale then presented should not be accepted by the management. Under Amalgamated Association rules ten men can form a union and get a charter. Thus the hot-mill men could get the picklers in, then the hot-mill men plus the picklers could get the cold-rollers in, then the hot-mill men plus the picklers plus cold-rollers could get the annealers in, and so on. The Republic Iron & Steel Co. bought a ten-mill sheet plant last year for the hot-mill labor of which the Amalgamated Association scale has hitherto been signed. According to the plan proposed, this could be used as a lever gradually to get the company's plate mills, pipe mills, bessemer converters, open-hearth furnaces and blast furnaces into the union class, bit by bit, otherwise down would go the Deforest sheet mills.

Needless to say the proposal was rejected and the scale conference adjourned, leaving it that the Amalgamated Association will after June 30 make all the trouble it can. So will the American Federation of Labor, and the two organizations will not work together, the point being that the officials of each organization wish to retain their positions. This may represent a new form of competition, but it is no new thing for labor organizations to compete with each other, as witness innumerable cases of construction jobs being held up because there was a plurality of unions desirous of doing the same piece of work.

Nothing has been said thus far as to what either organization wants for the men it is desired to unionize. That may be announced later if the leaders have the necessary leisure. The fact is baldly apparent that the main thing is to "organize" for the sake of organizing.

Something— But Not Enough

THE Sterling-Lehlbach bill, which provides for the retirement of Government employees, has just become effective, and those in the service above 62, 65 or 70 years of age, according to the branch of the service, are to be retired on a pay which is pitifully small, especially for those who have occupied responsible positions. After thirty years of service, retirement is on the basis of 60 per cent of the salary, but a maximum of $720 per year limits the retirement pay. Those who have been fifteen years in the service retire on a 30 per cent basis, but here again the maximum retirement pay is limited to $360 per year.

It is certainly gratifying to know that Congress has at last recognized the principle of retirement provision for superannuated civilian employees. However, it is not pleasant to consider the situation of a technical expert who has been in the service for thirty years and who under the new law is required to surrender 2½ per cent of his basic salary, being provided with the munificent reward of $60 per month when he retires for old age. The professional men of the country cannot look with satisfaction upon such an arrangement.

It is up to us, therefore, to get busy and see that a more nearly adequate arrangement is made for the retirement of specialists. Particularly for those in technical and other professional lines the retirement should be upon a basis comparable with the dignity of the position which they have occupied. This is only one of the efforts which is essential in order to restore the Federal services to that position of self-respect and reliability which can reasonably be demanded if proper care is taken of the individuals' interests, both during and after public service.

Readers' Views and Comments

Putrefaction and Decomposition

To the Editor of Chemical & Metallurgical Engineering

SIR:—Dr. George L. Hagadore of Chicago has contributed an illuminating article to *The Undertakers Journal* on Putrefaction and Decomposition, which is so replete with chemical and biological news that I offer some notes taken from it as a worthy supplement to Prof. Moadinger's masterly contribution to corpse chemistry which I abstracted and which you were good enough to print some time ago.*

"Decomposition," says Dr. Hagadore, "is the separation of the component principles of the body, which are organic, nitrogenic or proteid compounds . . . . The separation takes place by chemical analysis under conditions causing fermentation." Of cells he says that "like all organic structures they have a limited period of life, their continued decay and death necessitating reproduction, which takes place in higher animal life by fission." "Blood," he continues, "is another unstable tissue," and he says it is the first tissue of the body to decompose.

"The body has fifteen chemical elements, all of which are combined in characteristic proportions (by the law of chemism) to form compounds, the proximate principles of which are about one hundred, which are divided into four classes, viz., inorganic, organic, non-nitrogenized, organic-nitrogenized and the principle of waste. Chemical elements, with the exception of the gaseous oxygen O_{16}, hydrogen H_1, and nitrogen N_{14}, do not exist alone in the body, but form compounds. The proximate principles O_{16}, H_1 and N_{14} are gases possessing great atomic heat, while C_{12} has the greatest atomic cohesion. O_{16} will combine with all the elements except fluorine, FO_2." The function of O_{16} "appears to be the oxidation of albuminous, oleaginous and saccharine compounds to their ultimate forms of urea, carbonic acid, etc."

Later on the author states that "according to the Law of Chemism, atoms are not satisfied to remain in complex compounds, readily giving up the unsatisfied atoms from molecules in the compound, which is termed analysis, or chemical decomposition of the body."

The sequelæ of decay are described in rather minute detail and the phenomena are explained by the statement that "the gases that chemists and pathologists describe are purely new chemical compounds caused by the chemicals in the body readily giving up the unsatisfied atoms in the molecules and the atoms combining with the O_{16} gas, the H_1 gas and the N_{14} gas."

Here we have a remarkable example of the reach of technology beyond the advancement of pure science. Let us consider a few of the high lights of Dr. Hagadore's great research. We are told, for instance, that decomposition takes place by chemical analysis; that blood is a tissue, and of proximate principles, which will be a new concept to most of your readers, I believe. The reproduction of life in the *higher* animals by fission is a new biological idea. The principles of waste to some minds will probably involve C_2H_5OH, but the inert H_1 molecule will probably strike most readers as a novelty. It is not surprising, however, that such a super-ozone as O_{16} will oxidize the oleaginous and saccharine compounds of the body, whether it be dead or alive.

MARTIN SEYT.

*See CHEM. & MET. ENG., vol. 22, No. 11, March 17, 1920, p. 484.

Air Furnace vs. Cupola Semi-Steel

To the Editor of Chemical & Metallurigcal Engineering

SIR:—I have recently had occasion to refer to my remarks at the A.I.M.E. meeting, Feb. 16 to 19, New York City, reported on page 391 of the March 3 issue of CHEMICAL & METALLURGICAL ENGINEERING, as follows:

"Attention was called to the exceptional wearing qualities of some semi-steels by R. F. Harrington, who thought that real information was needed as to whether cupola or air-furnace semi-steel was superior for abrasion-resistant parts such as locomotive cross-head shoes. Mechanics generally prefer cupola semi-steel, even if physical tests appear quite similar. For determining this essentially practical point, a good testing machine should be designed."

The writer appreciates fully the difficulty often encountered in reporting absolutely correctly the statements of different speakers on such occasions. It does seem, however, in this particular case that some of my remarks were entirely contrary to the statements reported as above, as can be seen from the extracts from a copy of stenographic notes submitted by the Secretary of the A.I.M.E. for my record:

"This so-called semi-steel . . . has always been of rather great interest to the speaker from the standpoint of its wear-resisting properties. We hear a great deal about the high tensile strength, transverse load and the increased deflection that is obtained through the use of steel, as compared to metal which has been made without the use of steel. This is particularly true in the case of the frictional parts of the locomotive, where much material of both kinds as mentioned above is used. . . . I have often wondered how the wear-resisting qualities of these two metals would compare, viz., metal made through the use of steel and one through the use of the open-hearth or air furnace type of melting unit. . . . In the railroad world . . . are many able men who believe that the addition of steel materially reduces the wearing quality of a metal as compared to a metal of the same analysis obtained through the reduction of carbon by other means. I believe that . . . some endeavor ought to be made to test out the relative wear-resisting qualities . . ."

Boston, Mass. R. F. HARRINGTON.

Increased Production of Sugar in Belgium

The Belgian production of sugar, which in 1918 was 70,000 tons and in 1919 113,000 tons, will easily reach 160,000 tons this year and will cover the interior needs of Belgium without obliging it to have recourse to foreign stocks. If the production attains 200,000 tons, as it did several years ago, there is a possibility of a surplus for export.

American Society for Testing Materials

Review of the Technical Papers Presented Before the Meeting at Asbury Park, N. J., June 22 to 25, Especially Relating to Molybdenum Steel, Transverse Fissures in Rails and to Testing Machines

EDITORIAL CORRESPONDENCE

AMERICAN Society for Testing Materials held its twenty-third annual meeting at Asbury Park, June 22-25, 1920, which was quite well attended by men interested in different substances together comprising engineering materials either from a producer's or a consumer's standpoint. As formerly, the main activities were confined to committee meetings, only the finished result of which was exhibited in open meetings. Nearly a hundred changes or additions were made to the standard and tentative specifications, most of them being matters of detail.

One action almost promised a year ago, was left undone—the restoration of phosphorus and sulphur limits in steel. Many 1918 specifications were raised 0.01 per cent to admit the necessary war tonnage—half of them replaced last year on materials of special purity or composition, and the remaining specifications (comprising the largest part of the tonnage) left with high limits for twelve months more. Now comes the time to replace the lower limits, but the committee finds that the conditions existing a year ago still remain, consequently consideration will again be deferred for a year. No question was raised as to the possibility of "conditions"—principally high-sulphur coal—ever being better, lacking an insistent spur; meanwhile a joint committee[1] has embarked upon a pretentious investigation as to the effect of sulphur and phosphorus on tonnage steels. Before scientific results can be obtained from this investigation—if they ever are obtained acceptable to both producers and consumers—the psychological factor may have intervened, and the purchaser become so satisfied with higher sulphur and phosphorus shapes that he wonders at his former insistent demand for the lower limits. "Anyway, if the steel mills cannot produce the stuff you want, . . .?"

CORROSION OF SHEET METAL

Another important committee report was on the present condition of a great number of 16- and 22-gage corrugated sheets exposed to atmospheric conditions for several years. Three different sets were exposed, one at Annapolis, where deterioration has proved slow; at Fort Sheridan, where the conditions are more severe, and at Pittsburgh, where the sheets are failing badly. The May, 1920, inspection of the 41-months' old sheets at Pittsburgh showed that out of 146 sheets of copper-bearing steel and iron (including puddled and ingot iron, open-hearth and bessemer steel) all with copper content above 0.15 per cent, ranging from 0.18 to 0.62, forty-two have failed, or 28 per cent. Out of eighty-four non-copper-bearing sheets, containing copper less than 0.15, ranging down to 0.01 per cent, eighty-one have failed, or 97 per cent. Atmospheric conditions at Pittsburgh and Fort Sheridan therefore appear to be resisted better by corrugated sheets containing appreciable amounts of copper. Coupons reserved from all these exposed sheets will now be exposed in salt, mine, and tap water, to check the result of the atmospheric-exposure results. Exposure of galvanized and other protected sheets probably cannot be undertaken on account of the difficulty in guaranteeing unchanged location for the long term of years which would be required.

[1] CHEM. & MET. ENG., vol. 22, pp. 297, 609, 952.

SHATTERED ZONES IN RAILS

In discussing James E. Howard's paper "On the Shattered Zones in Certain Steel Rails, With Notes on the Interior Origin of Transverse Fissures," M. H. Wickhorst reviewed the gradual increase in our knowledge regarding simple transverse fissures. As these failures appeared (they were first described by Mr. Howard in 1911) the rails containing them were studied from many angles. Chemical analysis gave no clue to the trouble. Microscopically, the rails appeared all right. Tension tests cut from transversely-fissured rails gave consistent results in flange, web, or outside of head, yet the same tests from the interior of the head showed low ductility.

Transverse fissures, properly so called, were always characterized by a flat break, square across the rail. All these breaks showed a "detail fracture" consisting of a roughly oval area giving a bright silvery appearance, at the center of which was a granular spot—the so-called nucleus, apparently the point of initial growth. Suspicion that the interior of the rail head and base contained shattered metal became a certainty with Waring and Hofammann's[2] discovery of "worm holes"—deep gouges produced by the action of hot HCl on polished sections. Rawdon and Epstein[3] very elegantly proved that such deep-etching marks represented in fact pre-existing cracks in the metal, a conclusion which has been substantiated by other investigators in their efforts to locate them prior to acid treatment.

Literally thousands of minute fissures exist in the deep seated interiors of heavy, hard rails, unaccompanied by non-metallic inclusions, and following both the grain boundaries and crystalline cleavages. Rawdon believes intracrystalline directions predominate.) Howard, however, shows that they do not extend closer than $\frac{1}{2}$ to $\frac{5}{8}$ in. to the hot-sawed ends of the rail, so that the shattered zones are entirely surrounded by sound metal, a circumstance which leads both Howard and Wickhorst to ascribe their origin to a time subsequent to hot-sawing. Another possibility—not mentioned at the meeting—appears worthy of discussion, and that is that pre-existing cracks might be cured in cooling surface regions exposed by the saw. Doubtless the mechanical working effects caused by hot-sawing are not comparable to the rolling stresses induced below the lateral

[2] "Deep Etching of Rails and Forgings," *Proceedings*, A.S.T.M., 1919, p. 182.

[3] Bureau of Standards Technologic Paper No. 156. CHEM. & MET. ENG., vol. 22, p. 505. March 17, 1920.

surface. Summation of this evidence, together with collateral experiments on internal stresses in rails and steel tires, convinces Howard that such defects in the shattered zone are cooling or shrinkage cracks.

Relation Between Shattered Metal and Transverse Fissures

All agree that transverse-fissured rails should be avoided, but lacking definite information as to their nature and cause, not much progress can be expected toward their systematic elimination. Deep etching cracks seemed the first real clue. While Robert Job agreed with Howard that no connection has yet been established between shattered zones and transverse fissures, G. F. Comstock takes rather sharp issue with them and contends that at least one transverse crack may reasonably be assumed to pre-exist at the nucleus of a transverse fissure, even though none are found elsewhere in the piece.

In different stages of development transverse fissures are found in all sizes of rails. Among 663 fissures occurring on one railroad, 535 occurred on the gage side of the head, 128 over the web, and none on the outside of the head. Transverse fissures have been found 1⅛ in. from the end of a rail, a location where internal strains were certainly the dominant ones. Well advanced transverse fissures have been found barely an inch apart, a development which could not take place as a result of bending stresses, even though one is inclined to disagree with the author that the most recent track measurements show fiber stresses inadequate to account for the rupture of rails by bending alone. Howard's suggestion that shattered interiors may even suppress fissuring in service by allowing the diffusion and therefore relief of internal strains transmitted from the cold-rolled running surface is questioned by Rawdon, who said, "It would seem logical to infer that if several *incipient* transverse fissures form in close proximity to each other, the 'diffusive action' referred to should be sufficient to prevent further development so that *well-developed* transverse fissures ought never to occur in close proximity to one another." On the other hand, a sound rail possessing moderate ductility should be safer against internal fissuring; unfortunately modern traffic conditions need a strong rail, to withstand the track loads, and a hard rail, to prevent undue distortion —a combination in carbon steels which unfortunately demands large cross-section, high carbon and low ductility. Apparently traffic conditions and "margin of safety" in carbon rails are an almost impossible combination of requirements.

Molybdenum Steels

G. W. Sargent presented an interesting paper giving the results of experience with molybdenum as an alloying element, dating back to 1899. At that time he, as well as several other investigators, was handicapped by the fact that the alloying elements available were quite variable in quality. Saladin[4], Guillet[5] and Cohade[6] have described the properties of a number of molybdenum steels made at Creusot, which researches showed high Mo steels to possess a special constituent which makes the steels brittle and hard, and even develop transverse weakness.

Swinden[7] prepared several low-molybdenum quaternary alloys showing high strength and good ductility, resembling nickel and chromium : nickel steels. Adoption by the consumers has been slow, however, owing to the comparatively high cost of molybdenum and the uncertainty in quantity and quality of the supply. Investigations within the last few years show the metal to be comparatively wide-spread and plentiful, and at present ample producing capacity is available for any expected demand. Electric-furnace ferromolybdenum and chemically prepared calcium molybdate may also be obtained in quantity.

Manufacture

Sargent says that molybdenum alloys present no difficulties in any modern steel-making process. Calcium molybdate is not to be used in the crucible process, and in general, low-molybdenum ferros are to be preferred on account of their lower melting point and ready diffusion. A typical basic open-hearth heat from a campaign producing about 6,000 tons is cited showing a charge at 10 a.m. of 99,100 lb. clean scrap, 30,100 lb. cold pig and 73,100 hot metal, with some spiegel iron, nickel scrap and nickel metal. Additions in order are as follows: Carbon, three of limestone, four or ore totaling 11,000 lb., nickel, and four of ferro-silicon, this last at 11.16 p.m. Then quickly followed 1,000 lb. 16 per cent spiegel; 1,504 lb. 50 per cent ferromolybdenum, 3,150 lb. 66 per cent ferrochrome, and 1,500 lb. ferromanganese, and the heat, tapped at 11.56 p.m., teemed into 20 x 24 ingots with a recovery of 93 per cent. Analyses follow:

	Carbon	Mn	Cr	Mo	Si
Preliminary from laboratory	0.15	0.24	....	....	....
Added	0.19	0.61	1.02	0.347	....
Total	0.34	0.85	1.02	0.347	....
Final	0.30	0.64	0.77	0.350	0.12
Wanted	0.25 to 0.35	0.50 to 0.80	0.80 to 1.00	0.25 to 0.50	0.25

Yields for several heats averaged: Ingots, 87 per cent of melting; billets, 80 per cent; bars, 94.4 per cent of billets; total yield, 66 per cent of metal charged into furnace. Analyses from two 40-in. corrugated ingots made at the Bethlehem Steel Co. showed no excessive segregation of any element.

The author presented several diagrams similar to Fig. 1 comparing the physical properties of popular alloy steels with and without ½ to ¾ per cent Mo. Annealing these oil-quenched steels at progressively higher temperatures decreases the ultimate strength and elastic limit—which, by the way, are quite close together, and increases the reduction in area and elongation. These diagrams show consistently a high reduction in area with a relatively low elongation. Quenching from as high as 2,000 deg. F. does not impair the physical properties nor cause the grain growth characteristic of overheated steel.

Physical Properties

Structurally, a quenched steel low in molybdenum (C 0.32, Cr 0.90, Mo 0.40) is martensitic. Drawing at 900 to 1,000 deg. F. reverts this into fine short pearlite filaments, and at 1,400 deg. F. the ferrite colesces into rounded masses, when the steel is well annealed and machines easily. A higher molybdenum steel (C 0.39, Cr 1.05, V 0.17, Mo 0.87) is finely pearlitic on oil quenching from 1,600 deg. F., and remains unchanged until drawn at 1,400 deg. F., upon exceeding which it is annealed. Swinden's researches indicate that molyb-

[4] *Iron and Steel Magazine*, 1904.
[5] *Revue de Metallurgie*, 1904.
[6] *Jour. Iron & Steel Inst.*
[7] *Carnegie Research Memoirs*, vols. 3 and 4; Chem. & Met. Eng., vol. 22, p. 259, Feb. 11, 1920.

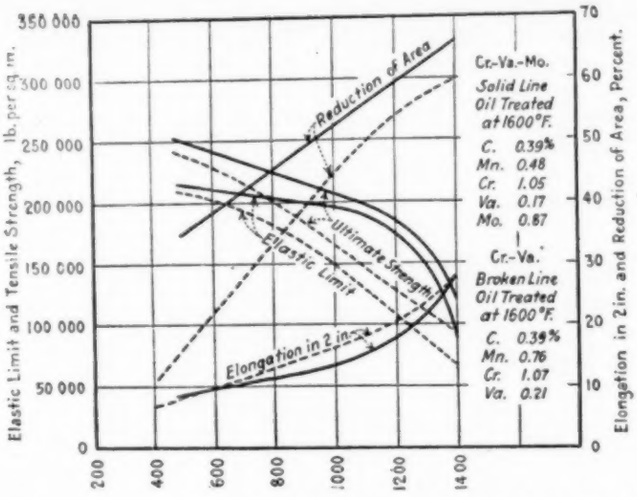

FIG. 1. COMPARISON OF CHROME-VANADIUM-MOLYBDENUM AND CHROME-VANADIUM STEELS, 1⅛ IN. ROUND BARS HEAT-TREATED IN FULL SIZE, THEN MACHINED TO 0.505 IN. DIAMETER

denum enters and toughens ferrite as solid solution when no Cr nor an excess of Mn is present. Otherwise it forms double carbides in addition, imparting additional hardness and strength. Thermal studies indicate that beyond 800 deg. C. (1,475 deg. F.) some compound is found in the austenite which upon cooling first dissociates at normal Ar, with precipitation of Fe_3C, later breaking up into a Mo:Fe compound at about 500 deg. C. (930 deg. F.), which further dissociates, giving a Mo:Fe solid solution only upon repeated reheatings. Hence the flatness of the physical properties vs. annealing temperature curves, and the persistence of the fine pearlitic microstructure.

Replying to questions, Mr. Sargent said that one of his torsion tests on low-molybdenum steels gave thirteen twists in an eighteen-in. length before breaking. Testing billets transversely to the direction of rolling gave no more evidence of transverse weakness than disclosed in carbon steels. Molybdenum added to gray cast iron in the ladle up to 4 per cent increased its tensile strength from 32,500 to 38,400, with a concomitant increase in Brinell hardness of 235 to 311. The graphite flakes were notably straighter edged and sharper. These results were substantiated by similar ones on semi-steel.

Non-Ferrous Alloys

Sub-Committee IX reported progress in its effort to systematize in some manner the names of ferro-alloys. Some idea of their task may be had from a glance at the list of usable alloys, twelve pages in length, among which there are perhaps 500 alloys known by name. How descriptive or apropos are these names may be inferred from the common "German-silver," neither German nor silver, or the designation of commercial aluminum mixtures by number (there are two No. 31's on the market at present). The committee recommends "nickelene" for Ni: Zn: Cu alloys, perhaps a doubtful improvement. However, no small advance would be made if a Zn: Cu alloy would always be some kind of a brass and not a "bronze" in order to denote some superexcellence imparted by a small percentage of a third element. A like committee of the British Institute of Metals believes that systematic names should have preference. The American committee recommends that commercial names which have become established by long usage, such as brass, bronze and cupro-nickel should be retained, differentiating by color, preferably. Thus a Zn 40 per cent Cu 60 per cent would be called a yellow-red brass. If it contained some tin it would be a tin yellow-red brass. Systematically the latter would be a tin-zinc-copper alloy, the first metal representing the smallest proportion, which must have at least 1 per cent present to be worthy of mention.

Effect of Tin on Brasses

William Campbell presented "A Note on the Constitution of Certain Tin-Bearing Brasses," in which he clearly explained the rather puzzling fact that a relatively slight variation in tin often causes the most profound physical changes in the alloys. Microscopically, some naval brass castings were found to resemble Muntz metal, in that they consisted of a mixture of alpha and beta constituents; some of them appeared like bronzes (alpha and eutectoid), while a third class consisted of alpha, beta and eutectoid. All of them were cast to the following specifications: Cu 60 to 65 per cent, Sn 0.5 to 1.5 per cent, iron 0.5 per cent maximum, Pb 1.0 per cent maximum, Al 0.5 per cent, Zn remainder.

He therefore studied the region of the ternary diagram shown in Fig. 2, both as cast and after annealing for two hours at 650 deg. C., and furnace cooled, finding results very similar to those of Hudson and Jones.[9] The alpha-beta-eutectoid complex is found in an approximately rectangular area, from which it is immediately

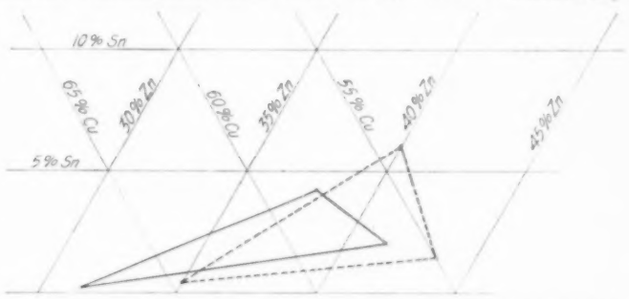

FIG. 2. PART OF Sn : Zn : Cu : TERNARY DIAGRAM, SHOWING STRUCTURE ANALOGOUS TO GUN METAL

seen that as the copper content of the cast alloy increases from 56.5 per cent, the amount of tin which will cause the alloy to change from the ductile "naval brass" type to the less desirable "gunmetal" type decreases from 2 per cent to less than 0.5 per cent with 67 per cent of copper. Consequently in proportioning such alloys it should always be clearly understood that the amount of tin should be inversely proportional to the copper. Corresponding facts for the annealed state are shown by the dotted triangle in the figure.

Testing Machines

A number of papers describing testing machines of various kinds were read, one attracting the most attention being perhaps that by A. S. Cushman on "A New Method of Testing Galvanized Coatings." This is merely a portable device for measuring the amount of hydrogen evolved when dissolving a given area of coating in concentrated HCl. A short length of 2½-in. tubing, properly convoluted on its bottom edge to fit the shape to be tested, is puttied down on the desired spot, closed with a stopper, connected to a gas burette and the entire system filled with water. Then by means of proper

[9] *Journal*, Institute of Metals, vol. 14, p. 98.

thistle tube, an undetermined quantity of HCl -$SbCl_3$ solution is introduced into the test ring, the evolving hydrogen being collected in the burette. Action is very rapid for about 30 seconds, slowing down to almost zero as the bare iron is exposed. The system is again washed out with water to insure all the hydrogen entering the burette, the volume noted, and by using a proper factor, the coating calculated in any units desired.

Hiding Power of Paints

"An Instrument for Measuring the Hiding Power of Paints" was described by R. L. Hallett. It consists merely of a long microscopic tube with plane ground glass for objective and small hole for ocular. If under this ground glass is placed a card having a contrasting stripe painted across it, the line of demarcation becomes more and more indistinct as the objective is withdrawn; finally a distance is reached where by diffusion the field appears uniformly illuminated. This vertical distance is measured and is found to be proportional to the contrast existing on the card under view.

The ground glass was prepared by polishing back an overground piece until a white card with a black stripe would become merged under view at an objective distance of about 15 cm. Calibration is required for each instrument, and is done by viewing various grays, ranging from best white to darkest obtainable black, each tone having previously been analyzed for white and black by a Howland color photometer. In this way a logarithmic curve was established, using objective distance as ordinate and per cent of hiding power as abscissa.

This instrument evidently can be used for any spreading rate, and for any color over any background. Its chief difference from the cryptometer[10] is that the latter measures 100 per cent hiding in liquid paint, while the new device measures to within 5 per cent any percentage of hiding less than 100 in a dried coat applied to any desired surface at any desired rate.

Colorimeter for White Paints

A. H. Pfund notes that heretofore it has been extremely difficult to evaluate various so-called white paints because their departure from white is so very slight, and in developing a "New Colorimeter for White Pigments" makes use of optical principles for intensifying these differences to measurable quantities. He defines a white surface as one which reflects white light nonselectively. While truly white light is as difficult of attainment as a truly white pigment, for practical purposes so-called white pigments may be compared by comparing the way they reflect blue, green and red light. If a certain paint reflects the three equally well, it is white; if blue is reflected less completely, the paint is not white, but reflects selectively, and in this case has a yellow tint—a condition common to all commercial "white" pigments. Sublimed magnesium oxide has a reflecting power of 87 per cent (the standard of brightness) and is practically white. Lithopone in glycerine, however, reflects red 77 per cent, green 75 per cent and blue 71 per cent. It evidently is not so bright as MgO, and in comparison will also appear yellow-tinted. On the other hand, Titanox reflects red 77 per cent, green 71 per cent and blue 64 per cent. It is even less bright than lithopone, and appears yellow to MgO, yet lithopone appears bluish when alongside.

Such numerical results define each paint uniquely, and make purchasing independent of standard samples. The instrument is reproducible at any point and dependent only upon physical constants. It is evidently useful in studying aging phenomena, the relation between hiding power and brightness, the effect of minute additions of colored pigments, and so on.

Briefly, the instrument intensifies selective reflection by multiple reflection of diffused electric light between parallel surfaces covered with the paint in question. Emerging beams are compared with the source by an ordinary photometer cube, viewed through screens of colored glass or solutions and a brightness match established and measured.

Plastometer

An improved plastometer which should be applicable to the investigation of many problems connected with paints, clays, greases, lards, soaps, lubricants and the like was described by Henry Green. As described a year ago in the *Proceedings*, the material under study is forced through a long capillary by air pressure, the rate of flow then being plotted against the pressure, or, more preferably, against the shear so induced. Rate of flow is measured by measuring the air displaced in the receiving vessel through a very delicate gas flowmeter.

Maxwell in his "Theory of Heat" points out that if any stress, no matter how small, be applied to a true liquid, a permanent deformation ensues. Flow-shear curves for liquids plotted by the plastometer agree with theory, since they are straight lines passing through the origin, the viscosity being a function of the slope. Plastic solids, on the other hand, require a certain definite unit force before flow (or deformation) occurs. Graphically, this means that the flow-shear curve should cut the X axis at a definite value ("yield value") equal to the shear required for incipient movement. Actually, at low pressures the curves for paint pastes (for instance) bend so as to approach the origin, apparently acting like viscous liquids at low pressures and as plastic solids at higher.

Microscopical observation of such capillary movement shows that at rest the vehicle wets the walls of the tube, the pigment touching the walls at but very few points and existing as interlocking floccules of relatively large mass. Slight pressure causes this interlocked mass to move *en bloc* so that shear is confined to the truly liquid vehicle. As the pressure increases, however, the pigment deflocculates, and movement is "telescopic," *i.e.*, the inner portions move much faster than the outer ones —true "fluid" motion. In this state lubrication is not complete and surplus force is required to overcome the largely increased friction between the moving particles.

From these results it appears that "plasticity" is a term of composite significance. Two substances may have the same yield value and yet one have a higher mobility (or fluidity, which is an analogous term) giving higher rates of flow for given pressures. On the other hand the mobility of a pair of substances may be the same, yet the more plastic would have the lower yield value.

True matching of plasticity is consequently a most difficult operation, involving substantial agreement of two pairs of factors, each to each, and can be successfully done only by painstaking studies by the plastometer or some instrument measuring the factors equally well.

[10] Journal of the Franklin Institute, Nov., 1919.

Legal Notes

By Wellington Gustin

Egyptian Lacquer Manufacturing Co. vs. Chemical Company of America

The Egyptian Lacquer Manufacturing Co. of Rahway, N. J., instituted suit for damages against the Chemical Company of America for pollution of water furnished it by the city of Rahway. The Chemical company attacked the complaint as failing to establish a right of action. This complaint set out that the city of Rahway is authorized by law to take such portion of the water of the Rahway River as may be required to furnish the inhabitants of the city with wholesome water for domestic and other uses; that the Egyptian company has a factory in the city for the manufacture of chemical products requiring a large quantity of water which was furnished it by the city; that the Chemical Company of America, having a factory at or near the river, emptied therein refuse from its factory above the intake of the city which so polluted the water furnished by the city that the complainant was injured in its use, and business was prevented from being carried on.

Is the Complaint a Cause of Action?

In passing on the law involved to determine whether the complaint disclosed a cause of action, the Supreme Court of New Jersey said it was clear from the complaint that although the city and the Chemical company are riparian owners, the Egyptian company is not, and further that there exists no contractural relation between the complainant and the Chemical company, or between the city and the Chemical company, as to the supply of water. This, said the court, presents the question whether, granting the right of the city to maintain an action against the Chemical company because of the pollution, the Egyptian company has such right, not being a riparian owner.

This is not a case of an indictment for creating or maintaining a public nuisance, or for the violation of any statute against the pollution of a running stream, but a suit for damages resulting from a special injury based upon the non-performance of a duty which the plaintiff claims was due to it from the Chemical company, and the claim is not sustained by the complaint, as the court found.

Dismissal of the Complaint

It says: "We may assume in this case that a liability existed in favor of the city as a lower riparian owner for the pollution of the stream by a higher riparian owner; but there the obligation ceased, for the right of action would not pass to a non-riparian owner merely because the latter had contracted with the city for the furnishing of the water, for his right depends upon his contract with the city, which might provide for the very character of water which was supplied. The liability of the defendant, if any, rests upon his violation of the legal right of a lower riparian owner, unless it had contracted with the plaintiff." But there was no claim of contract between the Chemical company and either the Egyptian company or the city. And if such a contract existed between the Chemical company and the city the court was of the opinion it could not inure to the benefit of the Egyptian company, as user of the city's water. Neither did the complaint show as a matter of law that the Chemical company as a riparian owner owed any general duty to the public or a special one to the complainant. The complaint was dismissed.

Agreement to Order as Soon as "a Car or Two" Has Been Used Held Valid

The Lakeside Forge Co., of Erie, Pa., has won in the Pennsylvania Supreme Court on its judgment against the Freedom Oil Works. An action for breach of sales contract for a year's supply of fuel oil had been entered into by correspondence between the parties. Defendant agreed to furnish oil and plaintiff accepted the offer, stating that it had a "car or two" coming from another source and would commence on the order "as soon as this is used up." This was on Aug. 16.

The Forge company by letter on Nov. 15 called upon the refinery for a car of the fuel oil, and two days later received a reply, refusing to deliver it, alleging that plaintiff's delay had operated as a cancellation of the contract. As a matter of fact plaintiff had seven cars of fuel oil coming on a former contract when this contract was made and this was the oil it used from August to November. The statement that it had a car or two coming was made honestly but without investigation.

The parties had further correspondence and telephone conversations, but the refinery refused to perform the contract, and plaintiff was forced to supply its requirements for the balance of the contract year from other sources of supply, at the prevailing market price. Then the present suit was brought to recover from the defendant refinery the difference between the price paid in the open market and the contract price. The trial court gave a judgment for this difference and the refining company appealed.

"A Car or Two" an Indefinite Number

The Supreme Court found the agreement, made by the correspondence, plain and said it obligated defendant to supply plaintiff's requirements for one year, less the amount due on a prior order. Until that was exhausted plaintiff couldn't demand oil on the contract in suit; hence defendant was not released because plaintiff failed to make a premature demand. Neither regarded the amount so due as the essence of the contract or attempted to fix it definitely. Plaintiff says "a car or two," and defendant says "to begin after you have taken out what is yet due you on previous contract." The court said "a car or two" signifies an indefinite small number and may include as many as seven. It is similar to "a few." Where indefinite words are used and the naming of the quantity is regarded, not as in the nature of a warranty, but only as an estimate of the probable amount, good faith is all that is required of the party making it.

Refinery Lost on Each Gallon Furnished

In a letter to plaintiff the refinery states the real truth that each gallon furnished under the contract would be at a considerable loss to it. But the court said the refinery would not be released from all liability for a year because by a fortuitous circumstance it was saved harmless for the first two months' supply. This was to defendant's advantage. And to justify rescission of a contract because of falsehood it must have been relied on by the complaining party to his detriment.

Notice to Discontinue Manufacture Relieves Buyer From Responsibility for Full Purchase Price

The Appellate Division of the Supreme Court of New York reverses judgment in the action of Frederick T. Commoss, as seller, to recover for 220 net tons of steel plates against William C. Pearson. These plates were to be shipped to a party in California, and from there exported to Japan. After the sales contract was made the Government promulgated a rule against exporting plates to Japan after a given date. The manufacturers of this plate, the National Enameling & Stamping Co., reported it impossible to make the plates before expiration of the time limit. The buyer failed to get an extension export permit, and wrote the plaintiff to do nothing further with the order for that time. The manufacturers replied to the buyer saying the order would be held until it heard from him again. The buyer further telephoned to the office of the seller, Commoss, and, not finding him in, gave the information to one McFarland, who promised to communicate same to Commoss.

At this time none of the plates had been made up. Later the full order of 220 tons of plates was rolled; this was done without any notice whatever from the buyer, Pearson.

The law applicable to the case is found in section 145, subdivision 4, of the Personal Property Law of New York, providing:

Provisions of the New York Law

"If, while labor or expense of material amount are necessary on the part of the seller to enable him to fulfill his obligations under the contract to sell or the sale, the buyer repudiates the contract or the sale, or notifies the seller to proceed no further therewith, the buyer shall be liable to the seller for no greater damages than the seller would have suffered if he did nothing toward carrying out the contract or the sale after receiving notice of the buyer's repudiation or countermand. The profit the seller would have made if the contract or the sale had been fully performed shall be considered in estimating such damages."

Now, said the court, if the buyer seasonably notified seller's agent not to proceed with the manufacture of certain steel plates, and also notified the mill which was making the plates, and the mill promised not to proceed further without notice from the buyer, the buyer was absolved, under the above law, from damages for labor and material thereafter expended in manufacturing the plates, and was not liable for the full purchase price on breach of the sales contract.

Buyer's Counterclaim Denied

Again, the buyer set up a counterclaim because the goods were not tendered to him within the time specified in the contract, but the court said he could not complain where he had directed the suspension of their manufacture until further notice which he had never given. Neither was the contract for the sale of steel plates for export an illegal contract because thereafter a Government embargo on such shipments was promulgated, where it is not shown that either party intended to make shipment without Government permit. The parties might lawfully stipulate that the payment should become due forthwith, as was done in this case, after the plates were rolled and before delivery.

The court said that undoubtedly all parties believed that the embargo upon the exportation of these plates would soon be released, and they acted accordingly; but neither the mill nor the seller had the right to proceed, after having been notified to suspend the manufacture until further notice from the buyer. If that further notice were delayed an unreasonable length of time, it would amount to an absolute repudiation; but when the mill acquiesced in the request to suspend the manufacture until further notice, and when such a request, transferred to plaintiff, brought no protest, the buyer might properly rest upon its liability for such damages as had accrued upon the contract at the time the notice was given, and the seller cannot hold the defendant to any greater damages.

The Borderland of Manufacturing — When Mining Is Also Manufacturing

The Supreme Court of Pennsylvania has been called to pass upon the question whether a mining company in that state was not really carrying on the business of manufacturing. The action was one instituted by the state against the Welsh Mountain Mining & Kaolin Manufacturing Co., and arose out of a statute allowing to mining companies an exemption from capital stock tax of so much of the capital stock as is used in manufacturing. The company claimed it was engaged in manufacturing and on that ground refused to pay the capital stock tax.

The facts were that the company was incorporated under the Pennsylvania laws for the purpose of "mining fire clay, fire sand, feldspar and kaolin, with the right to prepare for market and vend the product of their mines." This company, during the tax period involved in the suit, leased its property and plant to the Silican Products Co. and the Silican Sand Co., which operated the mining property.

Basis of the Claim

The mined rock is crushed and sieved to the desired mesh. The silica sand thus obtained is used principally for molding in the steel foundry trade, and to some extent for concrete in the building trade. The rock has no commercial use or value as rock, but when changed into sand is known in the trade as "silica sand," and is worth from 45c. to 60c. a ton, and is adapted in that condition to particular uses, for which it was not adapted as rock.

Not Manufacturing, Says Court

Now, the question presented for the court to decide was whether this was manufacturing within the statute exempting the company from the tax. The company mines the silica rock and reduces it to desired sizes or to sand. It is still silica rock or stone bearing the appearance of the article as it leaves the mine, said the court, but with no regular shape or fixed size in the portions into which the rock is broken by the crusher. The pieces are sold as they come from the crusher without any attempt to remove the irregularities of the edges or make the pieces of uniform shape. This process is not manufacturing, the court held. And the fact that clay of various colors is sometimes added to the sand when colored silica is desired does not change the situation, said the court. That application of labor to an article either by hand or mechanism does not make the article necessarily a manufactured article was announced as a settled principle of law.

Factors in the Conversion of Sodium Formate to Oxalate

A Study of the Temperature, Pressure and Caustic Composition Factors Influencing the Percentage of Conversion of Sodium Formate to Oxalate—Temperature Control Essential—Oxalate Conversion Curves and Interpretation

BY E. H. LESLIE* AND C. D. CARPENTER†

THE formate process for the manufacture of oxalic acid as used in Europe has many variations, but basically it consists in allowing carbon monoxide gas to react upon a heated caustic alkali in the presence of more or less water, the temperature being controlled so that the formate produced is not decomposed into oxalate and carbonate. Without attempting to show the mechanism, that is, the part played by the water, the reaction may be represented:

$$NaOH + CO \rightarrow H\text{-}C\begin{matrix}O\\ \diagdown ONa\end{matrix} + x \text{ cal.}$$

TEMPERATURE CONTROL ESSENTIAL

One of the greatest difficulties in so making sodium formate is the control of the temperature. Since the formate producing reaction is exothermic, a tendency to build up the temperature locally exists, thus bringing about a decomposition of the formate which has been produced. Fortunately the temperature at which formate is decomposed is considerably higher than that at which it is formed in the process under discussion, so that with adequate means of controlling the temperature difficulty need not be encountered in working the process. The temperature at which the decomposition referred to will take place and also the manner of the decomposition is a function of the composition of the material undergoing treatment particularly as regards its content of caustic alkali.

It can readily be seen that the controlling of the amount of caustic alkali in the finished synthetic formate is no easy matter, for while at the start of the reaction period the carbon monoxide comes in contact with the caustic readily, in the later stages of the conversion when the mass is pasty or solid the unconverted sodium hydroxide is brought in contact with the CO gas only slowly and with difficulty. Since the synthetic formate may thus contain caustic alkali, it is of importance to know what the effect of the presence of sodium hydroxide is on the conversion of the formate into oxalate.

TWO STAGED REACTIONS

Two main reactions take place when a pure formate is decomposed under carefully regulated conditions:

$$2H\text{-}C\begin{matrix}O\\ \diagdown ONa\end{matrix} \rightarrow \begin{matrix}C\begin{matrix}O\\ \diagdown ONa\end{matrix}\\ |\\ C\begin{matrix}\diagup ONa\\ O\end{matrix}\end{matrix} + H_2$$

sod. oxalate

$$2H\text{-}C\begin{matrix}O\\ \diagdown ONa\end{matrix} \rightarrow C\begin{matrix}\diagup O\\ -ONa\\ \diagdown ONa\end{matrix} + H_2 + CO$$

sod. carbonate

The second of these may take place in two stages: first, the formation of oxalate, and second, the decomposition of the oxalate into carbonate and carbon monoxide. It is of course necessary in commercial practice to avoid the formation of carbonate as far as possible, since the formation of this product results in a direct loss of oxalate, and also at a later stage in the making of oxalic acid in the loss of an equivalent amount of sulphuric acid.

The relative extent to which these reactions take place depends on temperature, pressure, and on the composition of the formate converted. As mentioned above, the content of NaOH in the formate is of special importance, and may introduce a further undesirable reaction, as we shall note below.

The experimental work which we report in this paper was designed to determine the effect of these various factors on the conversion of formate into oxalate.

CONVERSIONS UNDER VARYING CONDITIONS

Our study of the formate conversion involved the carrying out of a series of experiments in which approximately 10 g. of pure sodium formate mixed with definite amounts of sodium hydroxide were decomposed under carefully controlled conditions of temperature and pressure.

The sodium formate used contained 98.95 per cent formate and 1.0 per cent water. The caustic soda contained 92.25 per cent NaOH, 4.23 per cent Na_2CO_3 and 3.5 per cent water.

The formate and hydroxide were weighed out into a 250-c.c. round-bottomed flask, which was fitted with a one-hole stopper and pressure tube connection to a vacuum reservoir. This reservoir consisted of two 5-gal. glass bottles which were exhausted by an oil pump. A manometer indicated the vacuum in use.

When all was in readiness the round-bottomed flask containing the charge was plunged into a bath of molten nitrates of potassium and sodium contained in a 2-liter pressed steel bucket. The bucket was well insulated, and the bath could be maintained within 1 deg. C. with ease. Temperatures were measured by means of a Tycos nitrogen-filled mercury thermometer.

The flask was shaken vigorously in order to thoroughly mix the hydroxide and formate as the latter melted and the former dissolved in it, and to make uniform the temperature in the liquid mixture of these substances. The reaction was very vigorous in those cases where an extensive conversion took place, starting in from 2 to 4 min. and being complete very shortly

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thereafter. In some cases the decomposition was so rapid as to be almost explosive. In all experiments the heating of the flask was continued so that the total time was 15 min. The temperature of the bath in no case changed more than 1 deg. C. when the flask was plunged into the bath.

The conversion results in the formation of sodium oxalate and carbonate, which are solids at the temperature of the conversion. Consequently as the reaction proceeds the mass solidifies as gas is given off. This results finally in a puffed up, porous, white mass. The evolution of gas changed the pressure on the system somewhat, but this in no case amounted to a change of more than 40 mm. of mercury.

When the 15-min. heating period was complete the flask was removed from the bath, cooled, and the contents dissolved out. The oxalate was then precipitated as calcium oxalate, collected on a filter, washed carefully, redissolved in dilute sulphuric acid, and estimated by titration against potassium permanganate which had been standardized against pure sodium oxalate.

Discussion of Experimental Errors

It is evident that certain errors are unavoidable in the method we have used. One of these concerns the transmission of heat into the melted solids which are undergoing reaction. It is well known that in a case such as we are dealing with here the main resistances to the transmission of heat lie in the liquid or gas films on the two sides of the glass and not in the glass itself. The thickness of these films and hence their resistance to the flow of heat is greatly reduced by shaking the flask. In any event the results in our experiments are comparable in so far as temperature is concerned since the factors affecting heat transmission are substantially constant throughout.

We have mentioned the error due to change in pressure as the reaction proceeds. This of course influenced the results in a certain degree, but this pressure change was nearly the same in those cases where a considerable conversion occurred, and hence was nearly a constant factor. In those cases where little change occurred the pressure remained low, and as indicated in the results recorded favored the reaction. Hence the error does not destroy the conclusions drawn from the results.

Experimental Results

It is of course obvious that in order to accurately obtain continuous curves it would be necessary to perform many more determinations than are recorded as loci of the curves given, but it is believed that the data presented indicate with a fair degree of conclusiveness the effects of varying the conditions, temperature, pressure, and per cent of sodium hydroxide.

An inspection of the curves indicates that for given temperature and pressure there is some optimum percentage of sodium hydroxide. This shows up clearly in the curves, 2-in. mercury at 260 deg. C., 14 in. at 300 deg. and atmospheric pressure at 360 deg. C. It is probable that in all those cases where nearly quantitative conversions into oxalate were obtained with 1 to 1.5 per cent NaOH, a decrease in NaOH below 1 per cent and approaching 0 per cent would have given a markedly lower conversion.

The sodium hydroxide exerts a specific influence on the conversion of formate into oxalate which for want of an exact explanation we may call a catalytic influence. In addition to this catalytic effect the sodium hydroxide exerts a second influence which results in a lowering of oxalate yield. This is probably due to chemical reaction between the formate and hydroxide, thus

$$H\text{-}C\begin{matrix}O\\ \diagdown ONa\end{matrix} + NaOH \rightarrow C\begin{matrix}\diagup O\\ -ONa\\ \diagdown ONa\end{matrix} + H_2$$

But it may be the result of a catalysis by the hydroxide of the reaction

$$2H\text{-}C\begin{matrix}O\\ \diagdown ONa\end{matrix} \rightarrow Na_2CO_3 + H_2 + CO$$

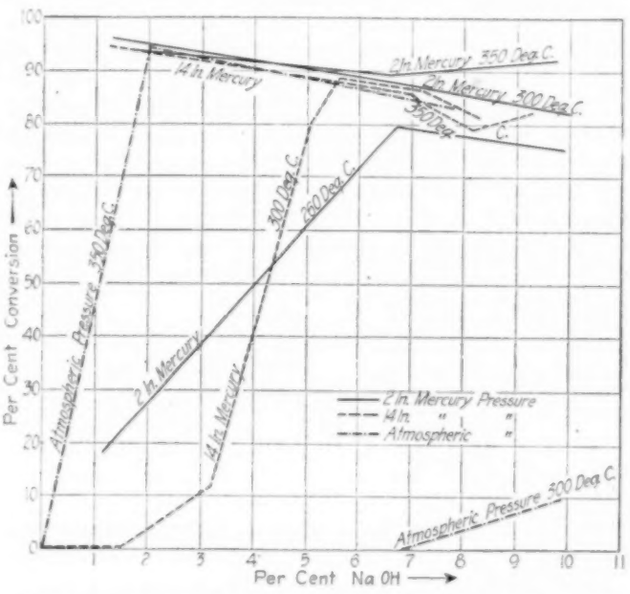
This latter reaction should probably be regarded as taking place in two steps: first, the formation of the oxalate, and second, the catalytic decomposition of the oxalate; thus

$$2H\text{-}C\begin{matrix}O\\ \diagdown ONa\end{matrix} \rightarrow Na_2C_2O_4 + H_2$$

$$Na_2C_2O_4 \rightarrow Na_2CO_3 + CO$$

Interpretation of the Curves

The point as to whether the NaOH reacts chemically with the formate, or catalyzes the carbonate forming reaction, or both, can be settled by analyzing the gases given off during the conversion and considering the



CONVERSION TO OXALATE FOR VARIABLE NaOH CONTENT AND AT DIFFERENT PRESSURES

hydrogen and carbon monoxide content of the gases in relation to the oxalate and carbonate content of the reaction product. We regret that we are unable to offer data on this point.

It is obvious from a consideration of the curves that an amount of sodium hydroxide approximating 1 per cent of the formate is the most desirable quantity to have present.

The curves show that the lower the pressure the more easily and effectively are the oxalate-producing reactions brought about. Too low pressures are undesirable from an operative standpoint both on account of cost and on account of the danger of explosion from a too rapid

reaction where fairly large quantities of formate are undergoing treatment.

In general we can say that increase in temperature produces increased yields. It is undesirable, however, to use temperatures over 360 deg. C. due to the increased rate of decomposition of the oxalate.

Considering the matter from the practical as well as the chemical standpoint, it is evident that the best conditions for the conversion of sodium formate into sodium oxalate are the following:

A proportion of NaOH approximating 1 per cent of the formate.

A pressure approximating 14 in. of mercury.

A temperature of 350 deg. C.

It is a matter of great difficulty to heat a large quantity of formate quickly to a temperature of 350 deg. C., and poor results will be obtained if the conversion takes place at lower temperatures when the pressure in use is 14 in. of mercury. The conversion process should therefore be a continuous one in which small quantities of formate only are subjected to the influence of the conditions at any one time. In this way the conversion temperature can be quickly reached, and danger of explosion which exists when large quantities are being handled is avoided. Following this general method we see no reason why results approximating a 90 per cent conversion should not be obtained in commercial practice.

Tests for Relative Corrosion

By Bertram Feuer*

Recently the researches of Bauer and Vogel,[1] Bengough and Hudson,[2] F. Goudriaan,[3] and the author with Reedy[4] have brought out some facts concerning corrosion that confirm the ideas worked out independently by various individuals using different methods of attack. In practically all these cases it was necessary to attack the problem from a more or less theoretical point of view and, no doubt, has led to promising results. Others, in their investigations, have worked for the sole purpose of seeking a remedy to counteract the deleterious action caused by the phenomena of corrosion. Among another group of workers can be classed those who have sought a means for testing or measuring the corrodibility of a metal in order to determine whether a particular metal would be best suited for a specific use. These workers have undoubtedly contributed matter of interest for the engineer who is confronted with the question from the practical standpoint and should have some means at his disposal for testing the suitability of his materials for various purposes. So far as sytematic testing is concerned, having regard to our present state of knowledge on the subject, this is out of the question.

For systematic testing it would be absolutely necessary to govern and study local conditions and other more or less accidental disturbances that occur in practice, but further difficulty is met with in sampling the metals to be tested, in reproducing the natural conditions of aëration, dilution, changes in electrolyte composition, slight mechanical abrasive actions, temperature fluctuations, etc. The oldest method is the immersion test.

Strips of the metal are carefully cleaned and weighed, and are placed in samples of water or exposed to similar atmospheric conditions as will be met with in practice (e.g., in air for outdoor construction; in fumes of chemicals for metal that is to be used in industrial constructional work). After a long period of exposure the samples are taken out, carefully cleaned, dried and weighed. The loss of weight per unit surface per unit time is the corrosion factor.

In addition to the above-mentioned objections of inability to reproduce natural environments, the method possesses two great disadvantages.

1. It is very slow; accelerated corrosion tests, such as immersion in 20 per cent sulphuric acid or in 7.5 per cent sodium chloride, or again, in 1 per cent ammonium nitrate solutions, have been proposed and attempted, but it is found that the corrosion factors do not, as a rule, bear any relationship to those where the conditions of nature are at least being partly reproduced.

2. Corrosion may be either superficial or in the nature of pitting. It is obvious that a "pit" is more deleterious to strength—the important factor in constructional work—than an equivalent amount of superficial rusting. On the other hand, superficial rusting would hinder the proper action of a water meter, while a "pit" would probably cause no trouble. The process above described makes no differentiation between the two forms of corrosion. A further discord between the factors of various investigators is caused by the nature of the preliminary cleaning to which the metal surface is subjected.

G. and M. Whipple[5] introduced an electrolytic test for corrosion in which the rate of solution was accelerated by making the test piece of the metal the anode of a cell driven by current from some external source. This form of test brings out the "pittings" on the surface of the metal with great distinctness, and serves as a method for indicating the nature of corrosion.

Another electrolytic test devised by H. Hansen and W. Lewis[6] for determining the mutual corrosive effect of two metals consists in connecting electrodes of the two metals through an ammeter, keeping the solution about the electro-negative metal saturated with air, and measuring the current in the external circuit. Provided some standard metal to form the one electrode could be agreed upon, this method, which eliminates the necessity for the external current required in Whipple's test, is a great simplification of electrolytic corrosion processes.

There is one other method of testing corrodibility devised by G. and M. Whipple. This may be defined as an electrical survey method. By means of a sensitive galvanometer and a traveling contact pole of copper wire, the other terminal being connected permanently to the plate of metal, the magnitude of the current flowing through the galvanometer, when contact is made in the surface of the metal, is determined. Uniformity of surface currents is taken to indicate low corrosive tendencies, while alterations of any magnitude are associated with a tendency to rust. The value of the method seems to be somewhat vitiated by the presence of the metallic traveling touch electrode, which must undoubtedly both affect passivity and set up local currents not necessarily of constant magnitude.

The author in his work on corrosion was interested in the problem concerning water-meters and therefore

*Chemist, Illinois State Water Survey Division.

[1] *Mitt. Kgl. Materialprüfungsamt*, vol. 36, p. 144 (1918).

[2] *J. Inst. of Metals*, vol. 21, p. 1 (1919).

[3] *Chem. Weekblad*, vol. 16, p. 1270 (1919).

[4] *J. Ind. Eng. Chem.*, vol. 12, p. 541 (June, 1920).

[5] *Eighth Int. Cong. App. Chem.* vol. 21, p. 155 (1912).

[6] *Eighth Int. Cong. of App. Chem.*, vol. 21, p. 43 (1912).

limited his study to the action of dilute solutions of the salts, commonly found in water, on brasses and bronzes. In this work a simple test with the ferroxyl indicator[7] was found useful. Later work suggested that the plotting of potential fall between the surface of the metal and the solution in which it is immersed, by the aid of an auxiliary electrode, would give figures equally significant in value and free from the disadvantage alluded to above. It should, however, be remembered that, according to theory, the rate of corrosion is determined solely by the magnitude of the local currents, and that determinations of e.m.f. are only of value in so far that they indicate solution-tendency and not the rate of rusting.

The apparatus used for this work is that ordinarily used for determination of emf. by means of a third electrode and is fully described in textbooks on theoretical electrochemistry. In this work the calomel electrode was used. For measurement of the current an ordinary instrument on which one scale division measured one milliampere was found convenient. A more sensitive current instrument was placed in the circuit in order to read current magnitudes between scale divisions of the larger instrument.

The samples tested were uniform in size, having a surface area of 20 sq.cm. Table I gives a list of the samples used together with their compositions.

TABLE I.

No.	Zn Per Cent	Cu Per Cent	Sn Per Cent	P Per Cent	Al Per Cent
1	5	95	..	..	..
2	10	90	..	..	..
3	20	80	..	..	..
4	30	70	..	..	..
5	40	60	..	..	..
6	..	92	8	..	..
7	39	60	1	..	..
8	..	95	4.5	0.5	..
9	92	..	..	..	8
10	(c. p. Zn)	..	..	..	..
11	..	(c. p. Cu)	..	..	..

The accompanying figure shows the results obtained with the ten metals. The current values are plotted as ordinates and as a matter of convenience the logarithms of the potential values were used and are plotted as abscissæ. Upon examination of the curves the relative corrodibility of the ten metals when immersed in a 0.1 normal solution of KNO_3 is evident. These results, in a sense, check with those obtained by using the ferroxyl indicator referred to above. The use of this method has proved very interesting and it is hoped that in the near future it will be possible to study other alloys together with a variety of solutions, whereby some reliable data can be obtained and possibly a satisfactory practical method of testing be devised.

Urbana, Ill.

The Lead and Zinc Industry in Japan*

LEAD is mostly found in the form of galena, which is closely associated with zinc-blende ores. The principal lead mine in Japan is the Kamioka, in Gifu Prefecture. Inquiry at the Mitsui Mining Co. (Mitsui Kozan Kabushiki Kaisha) showed that in 1918 the output of this mine was 7,408,309 lb. of lead.

The quantity and value of the annual production of lead in Japan from 1913 to 1918 is given in Table I.

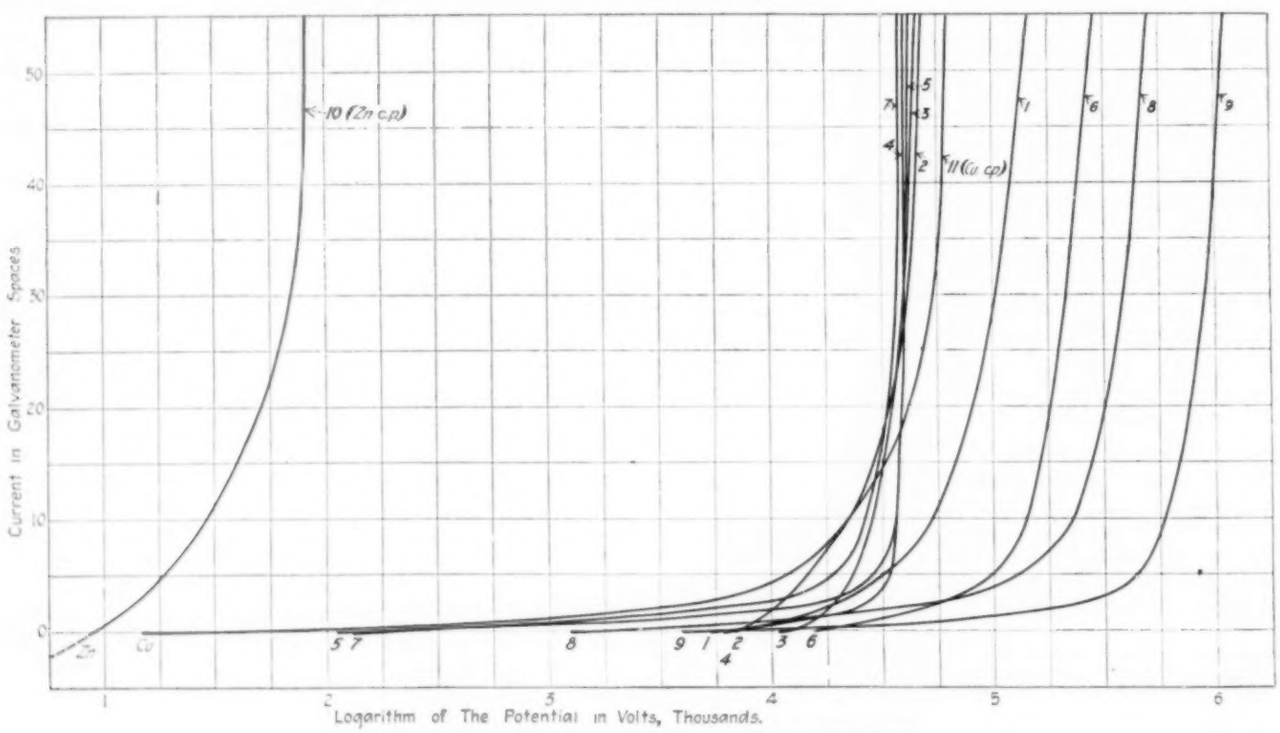
TABLE I. PRODUCTION OF LEAD IN JAPAN, 1913–1918

Years	Lb.	Value	Years	Lb.	Value
1913	8,393,138	$308,006	1916	25,268,685	$1,872,332
1914	10,138,205	412,400	1917	35,127,077	2,822,018
1915	10,567,457	486,729	1918	23,742,236	2,070,266

Okayama Prefecture leads in lead production. In 1918 the amount was given at 7,573,669 lb., valued at $675,975. Gifu Prefecture was next with 7,440,368 lb., valued at $646,442. Other principal lead producing Prefectures, in the order named for 1918, were Fukuoka, Miyagi, Akita and Yamaguchi.

Producers and smelters were buoyed up by high prices

*Report of Vice-Consul H. T. Goodier, Yokohama, *Commerce Reports*, May 24, 1920.



RELATIVE CORRODIBILITY OF METALS TESTED

ruling during the war and by the hope that strikes and political conditions in the United States, Spain, Australia and Mexico, the principal lead-producing countries of the world, would create a world-wide shortage. However, this hope does not seem to have fully materialized, and the lead market has become quiet as a consequence. Paint manufacturers, having lost a considerable share of their trade with Singapore, the East Indies and India, as a result of renewed competition from Europe, are buying lead for actual needs only. This, together with increased cost of materials for smelting and higher wages, has caused a considerable reduction in output as compared with 1917. If the 1919 figures were available they would undoubtedly show a still more noticeable decrease in amount and value, many of the companies having been forced into financial difficulties.

Prices for lead (Australian) reached their highest in September, 1918, when 1 picul (about 133 lb.) was worth $15.52 in Yokohama. The lowest was $5.85 per picul, in June, 1914. In March, 1920, the price was $13.21, a recovery of about $4 per picul since last October. However, mounting costs make lead mining and smelting increasingly less profitable to the small company run uneconomically, as most of them are, especially in view of high transportation charges. The cost of production of refined lead is estimated at about $8 per picul at the smelters.

Imports of lead and lead ore into Japan from 1915 to 1919, largely from Australia (for lead ingots and slabs), are given in Table II.

TABLE II. IMPORTS OF LEAD AND LEAD ORE INTO JAPAN, 1915–1919

Years	Lead Ore		Lead Ingots and Slabs		Other	
	Lb.	Value	Lb.	Value	Lb.	Value
1915....	(a)	(a)	32,279,973	$1,450,656	2,872,805	$175,860
1916....	(a)	(a)	46,230,232	3,720,089	3,460,964	278,704
1917....	50,520,532	$1,253,759	35,024,068	2,926,798	1,567,652	144,154
1918....	7,989,466	191,130	120,283,002	7,351,379	1,447,808	153,538
1919....	330,667	8,007	79,607,814	5,432,046	(b)	(b)

(a) Not known. (b) Statistics not yet available.

In 1915 Australia sold to Japan 24,599,868 lb. of lead ingots and slabs, valued at $1,102,933. The same year the United States sold to Japan 5,790,156 lb., valued at $248,307. In 1919, while imports of lead slabs and ingots from Australia had increased to only 32,366,341 lb., valued at $2,551,042, imports from the United States jumped to 27,239,280 lb., valued at $1,604,866.

In 1914 Japanese consumption of lead was estimated at 43,753,000 lb., a great share of which was imported from Australia. In 1918 the estimated consumption had reached 144,025,000 lb.

Imports of White and Red Lead and Litharge

The imports of white and red lead and litharge, most of which came from the United States, are given in Table III.

TABLE III. JAPANESE IMPORTS OF WHITE AND RED LEAD AND LITHARGE

Years	Lb.	Value
1916	323,445	$31,365
1917	14,973	2,419
1918	18,401	2,661
1919	212,912	20,995

Lead is not exported from Japan in quantities sufficient to classify separately.

Only since 1913 has Japan engaged in zinc smelting. Prior to that time zinc ore was shipped abroad and the refined product then imported. The largest zinc mine is the Hikoshima in Yamaguchi Prefecture. In 1918 the production of this mine was given as 27,672,960 lb. of zinc and 230,720 lb. of lead. The estimated consumption of zinc in Japan increased from 25,512,000 lb. in 1914 to 60,761,000 lb. in 1918. Consumption has, however, very materially decreased since 1918.

Table IV shows that the production of zinc ore has been steadily declining since 1913, but that the output of refined zinc increased until 1918, in which year a decrease is shown.

TABLE IV. PRODUCTION OF ZINC ORE AND REFINED ZINC

Years	Zinc Ore		Refined Zinc	
	Metric Tons	Value	Lb.	Value
1913	34,676	$472,303	(a)	(a)
1914	14,138	140,752	13,140,265	$682,454
1915	6,121	179,845	46,958,601	6,456,866
1916	2,187	91,257	86,652,236	13,567,052
1917	163	13,576	121,596,436	13,462,153
1918	(a)	(a)	88,701,073	8,838,867

(a) Production not stated.

European Demand Stimulates Zinc Industry

When the war broke out, zinc experienced a boom in Japan, due to heavy demands from Great Britain and Russia. Prices went up, and many new companies, both mining and smelting, were formed. While there was a large disparity between costs and selling prices, these companies all made good profits. However, with the beginning of summer, 1916, prices started to go down. With decreased foreign demands and increased cost of production and transportation charges, many of these companies have had to either temporarily suspend operations or considerably restrict their activities, the latter course being taken by several of even the middle-sized companies. Much of this financial trouble noticeable among the smaller zinc operators is probably due to pyramiding subscribed capital on the basis of abnormal profits and excessive dividends declared, instead of creating and maintaining a safe reserve fund.

The estimated cost of production of refined zinc at the smelters is about $11 per picul (133⅓ lb.). Prices of 98 per cent pure zinc per picul ranged from $6.41 in June, 1914, to $27.40 in December, 1915. Since then prices have hovered around $12 as an average. In March, 1920, the price per picul was $13.96. The margin of profit, considering transportation charges, is thus proportionately low at present.

Yamaguchi Prefecture led in zinc production in 1918 with 27,672,972 lb., valued at $2,535,822. Fukuoka and Okayama followed in the order named, with over 18,000,000 lb. each. Other important producing centers were Miyagi, Hyogo, and Osaka.

Operation of Mines

In Japan, the principal uses of lead are for the making of paint, cables and piping, and in producing acetic acid. The principal uses of zinc are for plating and making paints.

In the mining of lead and zinc, primitive hand methods are used by the smaller companies. The operations of the larger ones, however, compare favorably with those used in the lead district in Idaho. There are 2,364 miners employed in zinc mining, while 1,046 are employed in lead mining.

The Mitsubishi Kogyo Kabushiki Kaisha pay their miners an average of about 75c. a day, with two holidays a month. The underground miners work about 56 hr. a week; surface workers usually have a 77-hr. week.

TABLE V. IMPORTS OF ZINC ORE, INGOTS, SLABS AND GRAINS, SHEETS AND WASTE

Year	Ore		Ingots, Slabs and Grains		Sheets		Waste	
	Lb.	Value	Lb.	Value	Lb.	Value	Lb.	Value
1915	(a)	(a)	6,487,784	$637,056	1,210,109	$157,277	11,125,057	$769,465
1916	(a)	(a)	7,218,985	980,277	1,203,998	228,577	4,401,937	427,889
1917	207,450,533	$3,899,905	10,015,693	879,392	2,694,159	595,171	1,633,445	110,124
1918	133,093,068	2,433,883	5,443,656	681,263	2,981,136	759,511	1,622,656	122,903
1919	61,845,733	1,122,932	12,629,181	1,463,480	3,276,672	555,480	722,444	36,661

(a) Not known.

The imports into Japan of zinc ore, of ingots, slabs, and grains, of sheets, and of waste during the past five years are shown in Table V.

During 1917 and 1918 a great deal of zinc ore was imported for smelting, mostly from Australia. However, since 1918 imports of zinc ore have decreased considerably, owing to a smaller foreign demand for the refined article, thus causing many smaller smelters in Japan to suspend operations.

Although no definite statistics in support thereof can be presented, indications are that foreign refined zinc and zinc manufactures, principally sheets from the United States, will once again find a growing market in Japan, owing to transhipping and speculative activities in connection with the increased demand for plating in China.

Exports and Principal Countries of Destination

The exports of zinc ore have shown a steady decline since 1915, when they amounted to 13,618,250 lb. On the other hand, exports of zinc ingots and slabs increased until 1917, since when they have shown a noticeable decrease. Japanese exports of zinc ore and of ingots and slabs from 1915 to 1919 are given in Table VI.

TABLE VI. JAPANESE EXPORTS OF ZINC ORE AND INGOTS AND SLABS

Years	Zinc Ore		Zinc Ingots and Slabs	
	Lb.	Value	Lb.	Value
1915	13,618,260	$179,846	(a)	(a)
1916	4,865,332	91,258	51,586,452	$9,596,461
1917	362,400	13,576	81,853,012	10,442,511
1918	11,332	234	37,739,584	4,519,766
1919	(a)	(a)	12,629,180	1,463,480

(a) Statistics not available.

The principal countries of destination for the exports of zinc ingots and slabs during the past three years were as follows:

TABLE VII. COUNTRIES OF DESTINATION FOR EXPORTS OF ZINC INGOTS AND SLABS

Countries	1917		1918		1919	
	Lb.	Value	Lb.	Value	Lb.	Value
Asiatic Russia	16,370,736	$1,943,703				
British India			7,851,343	$931,442		
China					2,912,616	$296,935
France	13,277,885	1,777,815	15,802,908	1,753,365		
Great Britain	42,452,701	5,472,124	9,330,916	1,166,264	8,586,588	1,048,423
Kwangtung Province					357,452	30,946

Japanese Imports of White Zinc

The quantity and value of the imports of white zinc into Japan during the past five years are shown in Table VIII.

TABLE VIII. JAPANESE IMPORTS OF WHITE ZINC

Years	Lb.	Value
1915	632,958	$52,133
1916	557,941	65,379
1917	97,026	5,143
1918	497,112	26,146
1919	212,912	20,995

Water-Power Development in Canada

The Dominion Water Power Branch, Department of the Interior, and the Dominion Bureau of Statistics, Department of Trade and Commerce, have just published the results of an exhaustive census and analysis of the developed water power of Canada. Their report, with figures complete to Jan. 1, 1920, is of exceptional interest as indicative of the extent to which the water resources of the Dominion are being put to advantageous use.

Practically every great industrial center in Canada, the report declares, is now served with hydro-electrical energy and has within easy transmission distance ample reserves of water power. Active construction in hydro-electrical enterprises is fast linking up the few cities which are still unserved and which have water-power reserves in their vicinity.

Horsepower Installed

There is installed throughout Canada about 2,418,000 turbine or water-wheel horsepower, of which 2,215,000 hp. is actually and regularly employed in useful work. The larger figure includes the total installed capacity at full gate, including reserve units. It does not, however, include hydraulic exciter units. A large number of the plants now operating are designed for addition of further units as the market demands. The ultimate capacity of such plants and that of new plants now under construction total about 3,385,000 hp.

Of the total power installed 1,756,791 hp., or 72.7 per cent, is installed in central electrical stations. By central electrical stations are meant stations which are engaged in the development of electrical energy for sale and distribution. Central station power is sold for lighting, mining, the electrochemical and electrometallurgical industries, milling and general manufacturing. In the pulp and paper industry 473,265 hp. is utilized, of which 381,631 hp. is generated directly from water in paper and pulp establishments, while 91,634 hp. is purchased from hydro-central electric stations.

Other Uses of Energy—Capital Invested

Hydropower used for other purposes and other industries may be listed as follows: For lighting, 434,613 hp.; in the mining industry, 177,728 hp.; in flour and grist mills, 42,736 hp.; in lumber mills and sawmills, 37,918 hp.; in other manufacturing industries, 172,955 hp. In further reference to the foregoing total of water power developed in Canada it ought to be noted that during the fiscal year ended March 31, 1919, there were exported from plants included in the tabulation 175,000 hp.-yr.

The total installed water-wheel and turbine power in hydro-central electric stations is 1,756,791 hp. Fuel auxiliaries installed as standbys in these hydro stations bring the total installed primary capacity up to 1,873,989 hp., connected to 1,449,180 kva. dynamo capacity. The total capital invested in these central stations, inclusive of transmission and distribution systems, is $369,464,961, or an average of $210 per installed primary horsepower.

Scientific Control of the Filter Station—V

General Discussion and Summary of Features on Filter Press Operation—Types of Presses and Their Application—Materials Used in Construction of Presses—Pressure Devices—Scope of Centrifuging, Decantation and Flotation*

By ARTHUR WRIGHT, M.E.

WHEN consideration is given to the fundamental principles of filtration in designing the machine and in operating it, no other system is as simple, direct and positive for the clarification of liquors handled in the industries. When, however, the operation or design of the filter is faulty, centrifugals, decantation methods, flotation schemes, etc., can be substituted and prove more economical.

It is rare that the work done in one operation by a filter can be duplicated by other methods without repeating the operation or supplementing with the use of a filter. The scum from flotation machines is washed and dried in filters, the residues from decantation installations dewatered in a filter and it is common to complete the clarification of liquids issuing from continuous centrifugals through a clarifying filter. Such methods savor too much of "two bites at a cherry" and can scarcely be considered when the correct filters are installed and operated properly.

Types of Presses and Their Applications

One cause for the substitution of filters is found in faulty design. This is not serious when insufficient filter area or cubical caking capacity has been provided, for such troubles are overcome by additional machines. When, however, wrong types are employed, real difficulties arise. It is becoming better recognized that no one filter can satisfy all requirements and that some types are better for some specific duties. The following classification meets general conditions although local considerations may require radical modification in it:

Plate and Frame Filter Presses—Dry discharge; material requiring frequent filter cloth removal; acids, saline liquors in machines of wooden construction.

Vacuum Leaf Filter—Acid filtration; open tank.

Pressure Leaf Filter—Generally applicable to all materials, but less satisfactory on acid liquors and those containing too freely filtered solids.

Vacuum Continuous Filters—Free-filtering solutions not too hot.

Vacuum Dewaterer Hoppers and Rotating Sand Tables—Crystalline or granular solids too fine for good centrifugation or corrosive to centrifugals.

The matter of design does not end with the selection and construction of the filter best suited for the material in hand, but must include the layout of the machine in the plant. It is most important that the layout be made so that the operator can conveniently observe the operation and handle the valves.

Materials Used in Construction

When handling acid liquors the amount and nature of the acid present will dictate the materials of construction to be used. But little reliance should be put on protective paints even when handling weak liquors and at relatively low temperatures. The coating is likely to be imperfect even when successive coats are applied, due to the practical difficulty of getting a clean, dry surface on which to apply the coating. The bond between the coating and the metal or material used is not great at its best, and one small exposed point is sufficient to soon nullify the whole coating. Enamel coatings are thoroughly resistant when well applied and free from cracks. Difficulty with this type of coating arises when working on liquors the temperature of which varies from room temperature, for the metal expands at a rate different to that of the coating and cracks develop in the coating. Much improvement in this regard has been effected by enamel manufacturers, and there is hope that eventually this difficulty will be overcome. Lead is highly resistant, but has the unfortunate property of expanding without contracting correspondingly. This is what gives the open tank filters such an advantage, for the creeping of the lead is in no degree as serious as with closed containers. In weak acids several alloys are put out which stand up sufficiently to be practical materials of construction. Here, however, as with the use of monel metallic filter cloths, the design must not allow local electrolytic action to be set up by the use of two dissimilar metals or alloys whose electrical conductivities are not approximately equal.

Alkali filtration prior to the advent of metallic cloths was a troublesome if not an impractical process for industrial work. Metallic cloths are today practical mediums capable of withstanding the action of the strongest caustic liquors, but there are principles to be observed if their application is to be economical or efficient. Most alkaline liquors carry materials in suspension or in solution that have a tendency to scale formation. When handling such materials it is almost imperative that an open weave of cloth be used, for the scaling effect is rapid upon the filter medium due to the lower pressure on the outlet of the leaf often being sufficient to induce evaporation with the consequent scale deposit. Obviously a closely woven or rolled cloth is rendered impenetrable quicker than a more open cloth.

Back Pressure and Suction Operation

In closed delivery pressure filters scale formation can be lessened and in some cases eliminated by maintaining sufficient pressure on the outlet of the leaves. With hot liquors this pressure lessens the boiling effect at the surface of the medium and with supersaturated liquors crystallization is retarded or eliminated when the liquor is under pressure. The amount of back pressure required is a variable with the material being

*For Parts I, II, III and IV, see CHEM. & MET. ENG., vol. 22, Nos. 22, 23, 24 and 25, June 2, 9, 16 and 23, 1920, pp. 1,015, 1,077, 1,119 and 1,201.

handled, but it will often be found sufficient when a standpipe is run to the floor above. Good design will make this a U pipe, broken at its high point to prevent any siphon action, and returning the effluent within the observation of the operator. Such a back pressure must operate to decrease the flow, but the amount of decrease can be offset with a higher pump pressure. Too many times this decrease is exaggerated. This same argument arises where a suction is put upon the outlet of a pressure filter. In either case the effective working pressure is the difference in pressure between that in the filter outside the leaves and that inside the leaves. Consequently a back pressure simply subtracts from and a suction simply adds to the effective pressure in pounds per square inch and surely the simplest expedient to increase the working pressure is to increase the pumping pressure.

When handling weak acids or alkalis with cotton cloths, provision should always be made to keep the cloths wet. If allowed to dry, the weak liquid becomes concentrated and will eat into the cloths. When a press is standing idle, it is good practice to fill it with water or to remove the cloths and submerge them.

Surmounting Difficulties of Vacuum Filters

Some important filter installations have been made of intermittently operated type filters where, from the nature of the material, continuous type filters would seem to have been the better machines. In these cases the continuous filters were found lacking by reason of their inability to deliver a positively brilliant filtrate and to hold their vacuum due to the excessive cracking of the cake when air dried. Both of these difficulties are surmountable, and continuous filters should have been used. To overcome the clarity objection the valve should have been constructed with another outlet which registers with the arc in which the filter cloth first dips into the liquor and the initial cake is formed. Here is the only opportunity for cloudy liquor, and the delivery into this outlet should be returned to be refiltered. For the second there is no good reason, with drum type filters at least, for blanking off the valve at the point where the cracks allow free air to pass through. In this way the capacity of the vacuum pump is maintained for effective suction and will be found well able to hold the required vacuum.

Means of Forcing Liquids Through Presses

The choice of pump to be used in pressure filtration is a matter of more moment than simply to supply sufficient pressure. Oscillating pumps have little to recommend their use in filtration, for the rising and falling pressure exerts a hammer-like action on the cake being formed and increases its resistance without adequate returns. Also, these pumps, even when supplied with ball valves, give much annoyance by the poor seating of the valves due to the grit and other solids of suspension wedging in the valves. The montejus system of feeding filters is without doubt the best from the filtration point of view, but is costly in compressed air consumption. Centrifugal pumps are becoming more and more popular for this class of work, and for most materials they are excellent. It is when handling flocculent precipitates and when the pump is too large for the outflow of effluent that there is any difficulty with this type of pump. In such cases the rotor becomes an agitator that is too effective in breaking up the flocculent precipitates whose preservation is necessary for good filtration. In overcoming this difficulty the rotary positive displacement pump is becoming more and more generally used and its freedom from valve troubles and oscillating pressures surely warrants its use. Provision must positively be made against excessive pressure occurring in the filter when using this type of pump, for they develop pressures dependent upon the power of their drive.

A common fault often met with is lack of uniformity in the percentage solids fed to the filters. Good filtration calls for a uniform mix of those solids that settle readily and those which settle with difficulty. This requires the use of efficient agitators and too much emphasis cannot be placed upon the admirable work now being done by the non-swirl agitators on the market.

Decantation and Flotation

Continuous decantation systems are highly economical methods for the handling of large volumes of liquors the solids in which settle readily and leave a satisfactorily clear supernatant liquor. Their low labor and operating costs as well as their automatic operation are distinct advantages. They are especially applicable for the handling of calcium sulphate thrown down from phosphoric, oxalic, citric and similar acids, for they are easily constructed acid proof to these materials and effect results seldom approached by filters working on the same liquors. By using weak liquor washes on the successive settlings so that the settlings progress from strong to weak liquors with a final mixing with fresh water, while the supernatant liquors advance from weak to strong liquor, all water entering the system leaves it as strong liquid and the settlings are discharged from the system low in soluble content. The final settlings can then be handled on a continuous type filter, if desired. The large area required for such an installation is prohibitive in some plants, but it will often pay to construct a new department for an installation.

Flotation methods of separation are effective in clarifying liquors the solids of which are capable of being propelled upward by reason of the bombardment of the fine air bubbles ascending through the liquor. In handling greases, gums, fats, etc., this method of separation has much to commend itself, for such materials are difficult to filter and do not settle or float readily.

The advance that has been made in clarification methods and apparatus by Americans is a just cause for congratulation for every citizen of our country. But plant superintendents and operators must still strive to overcome the inertia of being too easily satisfied with results obtainable in their plant, for true economical production can be had only by maintaining equipment and processes up to their maximum efficiency. It may not be amiss to report that some companies in their wisdom have periodic investigations made throughout their plants and count the expense well merited when the reports simply commend present working without making suggestions for improvements. The writer has endeavored to have such investigations inaugurated, for they are signs of true progress and the surest means of preventing dry rot in any organization. Along these lines it is also gratifying to note that more and more concerns are taking up the slogan "Instruct the Operator," for he, in the last analysis, should be the filter expert in his department if the company is to have the most efficient plant.

Motion of Droplets and Particles in the Field of the Corona Discharge

By an Appropriate Arrangement of Apparatus the Paths of Particles in Electrostatic Fields Were Determined—While Four Different Effects Can Be Distinguished, the Corona Discharge Is Largely Responsible for the Action of Cottrell Precipitators

BY RICHARD C. TOLMAN AND SEBASTIAN KARRER*

THE use of the corona discharge for the precipitation of fumes and smokes as in the Cottrell precipitator and for the production of chemical reactions as in commercial ozonizers has become a matter of considerable technical importance[1] It seemed to us possible to obtain a clearer idea of the nature of such discharges by following the behavior of droplets of liquid or small solid particles in the field of a corona current. The motion of these particles was found to depend not only on the potential gradient at the particular point in the field where the particle is located, but also on the type of ions present which could be adsorbed by the particle. The method is thus capable of giving considerable information as mechanism of the corona discharge.

INSTRUMENTAL SET-UP

The apparatus used consisted essentially of a transformer to provide the high voltage necessary for the corona current, a kenotron for rectification in case direct current was desired, a discharge chamber consisting of a central wire between two parallel sheet metal plates, jets for introducing droplets of liquid or solid particles into the corona field, electrostatic voltmeters for measuring the potential between the wire and the plates, an arc for illuminating the droplets or solid particles, and a camera for photographing their motion, all as shown diagramatically in Fig. 1.

The transformer was a Thordarson, wireless transformer, Type P, with an adjustable magnetic shunt giving potentials from 0 to 20,000 volts.

The kenotron was a General Electric low voltage kenotron. Most of the experiments were made with a single kenotron. It was found, however, that the general nature of the results was unchanged by the use of a transformer with split secondary and two kenotrons, thus providing a steadier direct current than with the apparatus connected as shown in the diagram.

The discharge chamber was constructed from two sheet tin plates 6 x 8½ in. placed 2 in. apart. The central wire was nichrome, 0.011 in. in diameter.

Jets for introducing the liquid droplets were made of glass drawn down to give a fine stream. The liquids were forced through under pressure, provided by a definite head of water, or by gas from cylinders maintained at a constant pressure with the help of a mercury manometer. The jet was arranged so that the droplets fell in a stream parallel to the central wire, in a line directly between the wire and one of the plates, and were adjustable as to distance from the wire.

Arrangements were made for grounding the jet when desired by introducing a fine wire into the jet close to its point of issue. In the case of a non-conductor like turpentine, to obtain the desired earthing effects it was necessary to introduce the wire into the stream after it actually left the nozzle. In the case of water the wire could be anywhere near the tip.

Electrostatic voltmeters were of the Braun type and General Electric attracted-disk type.

The arc was focused on a small hole in an opaque screen and the beam of light passed through a slit to limit the beam and remove stray light which would be reflected from the plates. The angle between the beam and the horizontal was adjusted to give the best illumination and this was obtained at an angle of about 28 deg.

The camera was provided with a lens having an effective aperture of 1 in. and a focal length of 4½ in. Exposures lasted for about $\frac{2}{3}$ sec. and the lines shown in Figs. 2 to 9 illustrating this article are each one the path of a single illuminated particle. This time of exposure was found sufficient to give the total path of

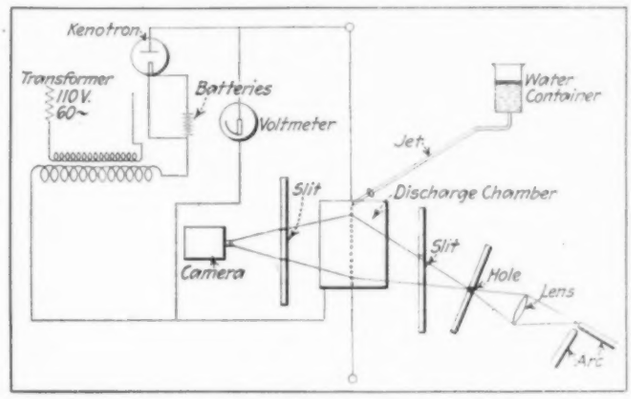


FIG. 1. DIAGRAM OF APPARATUS USED

the particle across the field of the plate. With shorter exposures it was possible from the length of path recorded to calculate the velocity of the fall of the particles, which in the case of the liquids with the pressures employed was in the neighborhood of 10 to 20 cm. per sec.

EXPERIMENTAL RESULTS

In order to describe the motion of droplets and particles in the field of the corona discharge, we have found it convenient to distinguish four different methods by which the droplets may obtain an electric charge—namely, (1) by electrostatic induction, (2) by conduction from the earth when the jet is grounded, (3) by the adsorption of gaseous ions, present in the field

Contribution from the Fixed Nitrogen Research Laboratory.
*Published by permission of George J. Roberts, Special Assistant to the Chief of Ordnance.
[1]The technical importance of the corona discharge was particularly called to our attention by the Bureau of Mines, which provided funds for a survey of existing Cottrell precipitating installations.

FIG. 2. WATER FALLING THROUGH NON-CHARGED FIELD
FIG. 3. INSULATED STREAM OF WATER ATTRACTED TO GROUNDED WIRE. PLATE AT —4800 VOLTS

of the corona discharge, and (4) by direct contact with the central wire. We shall now proceed to the discussion of these phenomena under the headings, "Induction Effect," "Earthing Effect," "Corona Effect" and "Contact Effect."

Induction Effect

When a stream of water was introduced into the field between the wire and plates, there was a general tendency noticed for the jet as a whole to bend toward the wire. This is apparently the familiar phenomenon of the motion of a particle having no initial charge toward the more intense part of an electrostatic field. This phenomenon results from the fact that charges of equal magnitude are induced on opposite sides of the particle, and since those on the side of the more intense field (in this case on the side of the wire) experience the more intense electrostatic force, the particle as a whole moves into the intense part of the field.

This effect is illustrated by Figs. 2 and 3. The former photograph shows the stream of water falling through the field of view without any potential applied to the discharge chamber. Fig. 3 shows the bending of the stream toward the wire owing to the described induction effect. In order to make it certain that this induction does exist and that the bending of the stream is not caused by the leak of electricity from the earth into the water, the water was insulated and the wire itself earthed, so that any leak to the water would give it a charge of the same sign as the wire and hence lead to motion away from the wire. In spite of this, the jet bends toward the wire as shown in Fig. 3, clearly demonstrating the induction effect.

It will also be noticed that the application of the electrostatic field leads to a spreading out of the stream of water. This may be partly due to the greater induction effect acting on the particles on the side of the stream nearer the wire, partly due to an actual separation by induction of electricity to the two sides of the stream, and partly due to the mutual repulsion of the different parts of the stream if it as a whole gets an electric charge by leak.

With a non-conductor like turpentine the induction effect could not be obtained. With small particles of aluminum and zinc the induction effect was very noticeable.

Earthing Effect

As already described, arrangements were made so that the stream of material issuing from the jet could be earthed, and the effect then determined of earthing either the central wire or the plates. At voltages which were not so high as to make the effect disappear in comparison with the corona effect, the motion of the earthed stream of droplets or particles toward the unearthed electrode was very marked. This is shown in Figs. 4 and 5.

In both these experiments the jet was earthed. In the first case the plate was also earthed, driving the jet sharply to the wire; in the second case the wire was earthed, driving the jet to the plate.

As might be expected, it was very difficult to obtain a decided earthing effect with turpentine because of its low conductivity. Benzyl alcohol showed less earthing effect than water; benzene and petroleum oil a very slight earthing effect. In the case of our metal particles, which were fairly large and of course of high conductivity, the separation of charges was so great that the induction effect always made the particles go toward the wire without reference to the earthing.

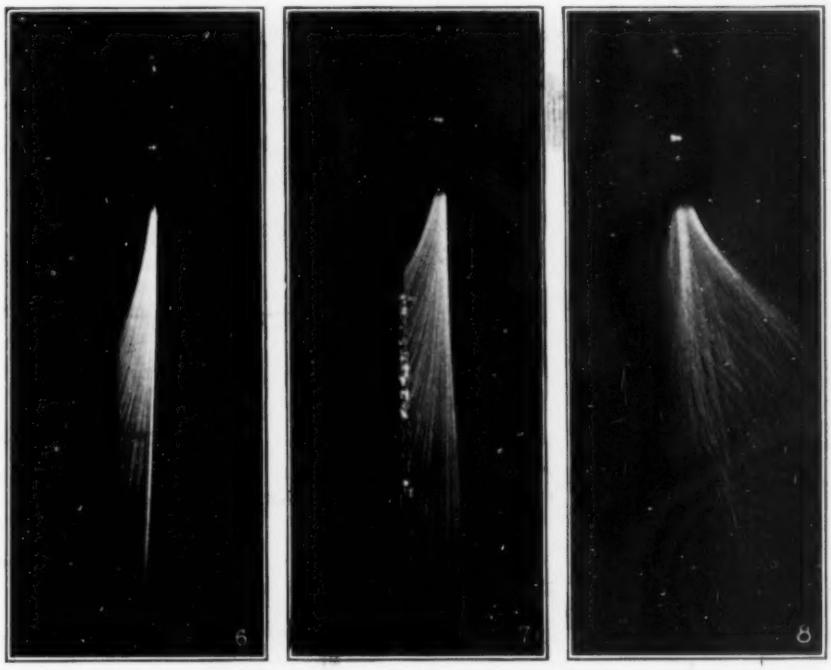
Corona Effect

As soon as the voltage between the central wire and the plates has been raised to a point high enough so that appreciable current begins to flow, as indicated by the well known hissing noise of the "silent" discharge,

FIG. 4. GROUNDED WATER BENT SHARPLY TO WIRE AT —2700 VOLTS. PLATE EARTHED
FIG. 5. GROUNDED WATER JET DRIVEN FROM EARTHED WIRE AT LEFT (NOT SEEN) TOWARD PLATE AT +2700 VOLTS

a new effect, which we have called the corona effect, becomes of great importance in determining the motion of the particles or droplets. Experimentally we find, under such conditions of high voltage, that the particles have a great tendency to assume a charge of the same sign as the central wire and move away from it. This corona effect occurs whether the central wire is positive or negative. If the plate is earthed and the jet of water also earthed, some of the particles can be forced toward the wire against the corona effect, at least for part of their path. With turpentine, the corona effect always predominates greatly over the earthing effect. With liquids of conductivity intermediate between turpentine and water the ratio of the corona effect to the earthing effect has an intermediate value.

The corona effect for benzyl alcohol is illustrated in Figs. 6, 7 and 8. In these experiments the plate was earthed and hence at a low voltage the leak to the benzyl alcohol from earth was enough to force the stream to the wire by the earthing effect which we have already discussed (Fig. 6). At a high voltage, however, as shown in Fig. 8, the corona effect completely overcomes the earthing effect.



FIGS. 6, 7, AND 8. INSULATED BENZYL ALCOHOL STREAM UNDER INFLUENCE OF CHARGED WIRE (AT LEFT) AND EARTHED PLATE

Fig. 6 at +2500 and Fig. 7 at +4000 volts show earthing effect. Fig. 8 shows corona effect preponderating at +8000 volts

It should be noted that the corona effect is of main importance in determining the behavior of Cottrell precipitators. Theoretically, we may explain this corona effect by reference to the probable mechanism by which the ionization necessary for carrying the corona current is produced. In the neighborhood of the central wire, the potential gradient is initially steeper than in the main portion of the field, owing to the geometrical configuration of the apparatus. Hence the major part of the ionization by collision necessary for carrying the current will take place in the neighborhood of the wire. Ions produced in this "ionization region" of the opposite sign to the central wire will be attracted to the wire and ions of the same sign as the wire will be repelled to the plates. Hence inside this "ionization region," ions of the opposite sign to the wire will predominate, thus increasing the initial steepness of the potential gradient which leads to the formation of the "ionization region." Outside of this small "ionization region" we may expect ions of the same sign as the central wire to predominate in number, and hence if our droplets or particles have anywhere near equal adsorptive affinities for positive and negative ions, they will obtain in general the same charge as the central wire and move toward the plate.

Looking at this theoretical explanation from the reverse point of view, it seems to us that the observed experimental facts demonstrate with a high degree of certainty that the space charge in the field of a corona discharge, except in the immediate neighborhood of the central wire, is of the same sign as the central wire. This disagrees with the conclusions of Booth[2], who found the density of the space charge to be zero over the largest part of the corona field. His method, however, involves besides the original uncertainties inherent in any method of using an exploring electrode, two successive graphical differentiations, obtaining quantities of nearly the same magnitude, which then have to be subtracted one from the other in order to obtain the desired density of the space charge.

The fact that particles and droplets pick up from the major portion of the corona field the same charge as the central wire with great readiness is further shown by their behavior in the field of an alternating corona current. This is illustrated by Fig. 9. Here, in spite of the fact that the current is reversing sixty times a second, the motion of the droplets of turpentine is almost uniform toward the plate. In other words, inside of a small fraction of a sixtieth of a second, the space charge and the consequent charge on the droplets reverse in sign. This observation explains the fact that it is possible to obtain some precipitation in the Cottrell process using alternating current.

Contact Effect

A fourth method by which particles may obtain a charge in the field of a corona current is by direct contact with one of the electrodes. In particular they may come in contact with the central wire, obtain a very heavy charge from the central wire and then be repelled with great violence right through the ionization region to the plate. This is shown in Fig. 10.

Corroborative Experiments With Single Particles

In order to confirm the existence of the induction, earthing, corona and contact effects by which a charge may be imparted to a particle, experiments were made on single particles suspended in the field on glass fibers and on thin metal wires. The phenomena expected were reproduced. At high potentials the particle was always repelled from the central wire by the corona effect, at low potentials the particle could be made to move toward either electrode desired by taking advantage of the

[2] *Phys. Rev.* (2), vol. 10, p. 266 (1917).

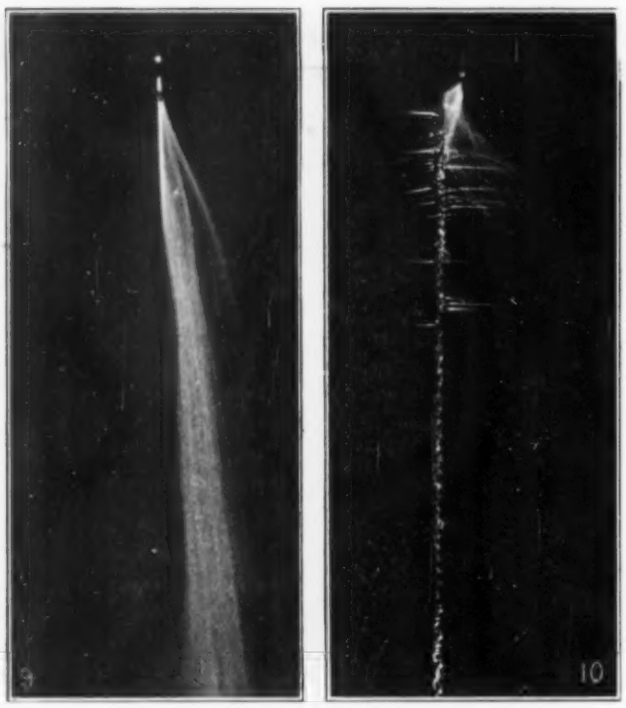


FIG. 9. INSULATED TURPENTINE DROPLETS DEFLECTED FROM WIRE CHARGED WITH 60 CYCLE ALTERNATING VOLTAGE OF ±9000. PLATE GROUNDED

FIG. 10. VIOLENT EXPULSION OF EARTHED WATER DROPLETS ON COMING IN CONTACT WITH WIRE AT +8000 VOLTS

earthing effect, and at any voltage the particle was repelled from the central wire after coming in actual contact with it.

Waterfall Effect

In connection with our experiments on the earthing effect, it was noticed in the case of water that the jet breaks into finer particles when positively charged than when negatively charged. This apparently means that the surface tension of water is lowered more by a positive charge of electricity than by a negative charge.

This conclusion would seem to stand in agreement with the phenomenon known as the waterfall effect—namely, that droplets of water naturally have more tendency to assume a positive than a negative charge of electricity. This would of course be expected if the surface tension of water is lowered more by positive than by negative electrification, since that would mean that the potential energy of the droplet is more lowered by positive than negative electricity, which means of course that there is more natural tendency for water to pick up positive than negative electricity, since in general electrostatic systems rearrange themselves in the direction of minimum potential energy.

Conclusion

It is believed that this article demonstrates the existence of four methods by which particles in the field of a corona discharge may obtain charges of electricity—namely, by induction, by conduction of electricity from the earth, by the adsorption of ions present in the corona field, and by actual contact with an electrode. The motion of the particles is determined by the charge which they receive by one of these methods and of course of the potential gradient.

It is shown that the space charge in the major part of the field of the corona discharge is of the same sign as the central wire, in contradiction to the conclusions of Booth.

It is believed that the adsorption of ions having the same charges as the central wire is the underlying process in the action of Cottrell precipitators.

An incidental observation on the behavior of streams of water shows that they break up into finer particles when positively charged than when negatively charged. This was shown to be in accord with the well-known waterfall effect.

Potash Mines of Alsace

French potash and the conditions of that industry, as viewed since the Alsatian district was incorporated in the national domain, are reviewed by the American Trade Commissioner in Paris.

With the exception of the Société de Kali Sainte Thérèse, under Alsatian-French control, all of the potash mines in Alsace were owned and operated by German companies before the war. The first company to extract potash in Alsace was formed in 1906. At the time of the armistice there were fourteen companies, controlling 109 concessions and seventeen mines, these companies being, in turn, controlled by four large groups. The Sainte Thérèse group controls thirty-three concessions, the Deutsche Kaliwerke group controlled forty-eight concessions, the Wintershall group thirteen concessions, and the Hohenzollern group fifteen concessions. The German holdings, under liquidation since the armistice, are being operated for the account of the French Government.

300 Per Cent Increase Since Armistice

Until the Alsatian mines passed under French control the German Government regulated the sale of potash from them and from the German mines in order to prevent overproduction and to keep prices at a uniform level. During the year 1913 the German and Alsatian mines produced 11,600,000 tons of crude potash, 6 per cent of this amount, or approximately 696,000 tons, being the quota from the Alsatian mines. When the Germans left, some of the mines were found to be in a flooded state, and considerable pumping and repairs were necessary. Since the armistice the production has been increased by more than 300 per cent.

The total production of crude potash for 1919 was about 550,000 tons. During this period the average production per miner was increased from 0.933 ton per day to 1.48 tons per day.

The estimated production of crude potash from the Alsatian mines during 1920 is 1,320,000 tons, or about 220,000 tons of pure potash. It is expected that this output will increase to 2,040,000 tons of crude, or 340,000 tons of pure potash, in 1921, and to 2,340,000 tons of crude, or 390,000 tons of pure potash, in 1922.

Lack of Transport Curtails Export

Since the armistice the United States has been unable to secure anything like the quantity of potash it urgently requires. This is due almost entirely to the transport crisis in France. The lack of railway transport likewise reduces the shipments of coal necessary for the reduction of the higher grades of potash.

It should be remarked that the mines now in operation in Alsace are alone capable of supplying the world's needs. Otherwise expressed, it is merely a matter of stimulating production to the required level. —*The Review*, May 15, 1920.

Economic Aspects of the Chilean Nitrate Industry*

A Summary of the Economic Features of the Chilean Nitrate Industry, Showing the World-Wide Requirements of This Chilean Natural Product for Agricultural and Industrial Purposes—Work of the Nitrate Producers' Association and Outlook for Future Developments

CHILE is the only country in the world known to contain commercially important deposits of nitrate of soda, a product which has a wide variety of uses, but is best known as a valuable fertilizer. Two grades of nitrate are produced: 95 per cent, or ordinary nitrate, which is used for fertilizer purposes, and 96 per cent, or refined nitrate, which is used for manufacturing purposes. Before the war approximately 75 per cent of the nitrate marketed was of the lower grade. Private business in Chile and government revenue are both dependent on the prosperity of the nitrate industry, since this one product ordinarily constitutes nearly 80 per cent of the country's exports, and the export tax on nitrate and its principal byproduct, iodine, constitutes more than half the government's total income.

There is a great deal of speculation concerning the probable duration of the beds, but the very range of the conclusions arrived at shows on what inadequate data they have been based. One expert estimates the explored deposits to contain 240,000,000 metric tons of nitrate, and calculates the contents of the unexplored region to be twice as large. According to these figures it would require over 240 years to exhaust the supply at the present rate of production. Other estimates are less optimistic and set a much earlier date for the exhaustion of the beds.

The nitrate region consists of five important districts.[1] The relative importance of the principal districts is shown in Table I, giving the number of oficinas producing plants operated in each district, the extraction of caliche (the raw product from which nitrate is produced), and the amount of nitrate derived, during 1917:

TABLE I. PRODUCTION OF THE PRINCIPAL NITRATE DISTRICTS IN 1917

Districts	Oficinas in Operation	Caliche Mined Metric Tons	Nitrate Produced Short Tons	Nitrate Produced Metric Tons
Tarapaca	76	10,330,984	1,433,213	1,302,921
Tocopilla	7	1,822,334	250,690	227,900
Antofogasta	30	9,172,026	1,184,225	1,076,568
Aguas Blancas	7	1,066,473	160,149	145,590
Taltal	9	1,923,257	272,858	248,053
Total	129	24,315,074	3,301,135	3,001,032

Caliche differs in appearance and composition in various zones. It usually contains (besides sodium nitrate) sodium chloride, sodium sulphate, potassium nitrate, sulphates of lime and magnesia, sodium iodate and sodium biborate in varying proportions. The sodium nitrate content varies from less than 10 per cent to over 70 per cent, the average sodium nitrate content of the caliche extracted during 1917 being 17.48 per cent.

Iodine, the most important byproduct of the nitrate industry, is extracted from the liquor which remains after the nitrate has been precipitated. Although some sodium iodate is contained in practically all caliche, iodine is produced by only a portion of the nitrate companies, and the output of these companies is carefully regulated by a producers' trust in order that the limited market may not be overstocked. The average pre-war exports amounted to approximately 475,000 kilos annually; but during the war, the exports were much larger; 708,800 kilos in 1915, 1,323,000 kilos in 1916, and 759,000 kilos in 1917. Germany was the principal purchaser of iodine before the war, the United States second, and Great Britain third.

Another byproduct, nitrate of potassium, is engaging the attention of various experts. One chemical engineer asserts that this salt exists in the caliche throughout all parts of the nitrate region and that the caliche used by at least a hundred of the oficinas contains from 1 to 2 per cent. An American company is reported to have perfected a refrigerating process by means of which it can manufacture this byproduct at small cost.

Cost of Labor and Supplies in the Nitrate Fields

The laborer in this arid zone requires great strength and endurance under the most trying of living conditions. The nitrate region produces no fresh fruits or vegetables, and he is obliged, therefore, to live largely on imported canned goods. He receives a far higher wage than any other class of Chilean laborer, but on the other hand the cost of all the necessaries of life is exceedingly high. To compensate the laborer for the hardships of the situation, the nitrate operators are compelled to provide living quarters for employees and their families and to maintain stores where they can purchase food, clothing and household furnishings.

At the outbreak of the war, 53,000 laborers were employed in the nitrate fields. Immediately afterward this number materially decreased, but in 1915 it began to increase again and in 1917 had reached 56,000. Of this number, about 43,000 were Chileans, and the remainder largely Peruvians and Bolivians. Before the war the average daily wage of the nitrate laborer was 6.48 Chilean paper pesos, and in 1917 the average wage was 6.81 Chilean paper pesos. (In 1914 the exchange value of the paper peso was about 20c.; during the war its value fluctuated between 14c. and 33c.)

Nitrate producers must import all their supplies, such as fuel, machinery and parts, and bags in which to ship the nitrate; and the cost of all these commodities has increased materially during the last few years. One manufacturer reported in 1918 that petroleum, which had formerly cost 41½s. ($10.98) per ton, then cost 150s. ($36.45); that the cost of coal had increased from 29s. to 115s. (from $7.06 to $27.95); and that jute bags, which he had formerly purchased for 3½d. (7c.) each, had reached the high figure of 22d. (46c.). A million tons of fuel was consumed in nitrate mining and refining in 1917. Of this total 65.5 per cent was

*Abstracts from Latin American Circular 67, Bureau of Foreign and Domestic Commerce.

[1]See CHEM. & MET. ENG., vol. 22, No. 14, p. 655.

petroleum, 28.6 per cent coal, and the remainder such fuel substitutes as straw and grain. Apparently no wood was used. Before the war most of the coal was imported from Great Britain. Petroleum comes principally from Mexico and the United States.

Nitrate is packed for shipment in jute bags holding about 200 lb. each. These bags are imported from India and about 30,000,000 of them are ordinarily used each year.

Relative Importance of Native and Foreign Companies

The greater part of the capital invested in the nitrate industry is Chilean and British. The amount of American capital in the field is relatively small but is increasing. German interest in the business was growing until checked by the war. The comparative importance of the native and foreign nitrate plants can be judged by their proportionate share in the total production for the year 1917, as shown in Table II.

TABLE II. COMPARATIVE IMPORTANCE OF NATIVE AND FOREIGN NITRATE PLANTS

Nationality	Number of Oficinas	Annual Production—Short Tons	Annual Production—Metric Tons	Per Cent of Total
Chilean	54	1,399,995	1,272,723	42.41
British	44	1,246,622	1,133,293	37.76
German	7	177,148	161,044	5.37
American	2	86,404	78,549	2.52
Peruvian	7	86,549	78,681	2.62
Spanish	4	76,639	69,672	2.32
Slavic	7	179,465	163,150	5.44
Others	4	51,613	46,920	1.56
Total	129	3,304,435	3,004,032	100.00

Sixty per cent of the nitrate manufactured by Chilean companies is the product of five large concerns, Compañía de Salitre de Antofagasta, Compañía Salitrera El Loa, Compañía Salitrera El Boquete, Compañía Salitrera Lastenia, and Compañía de Salitres y Ferrocarril de Agua Santa.

La Compañía de Salitre de Antofagasta is the oldest and one of the most important nitrate producers in the country. It owns a strip of nitrate land about 32 km. long by 4 km. wide in the Antofagasta district and employs 15,000 men. Its oficinas consume 80,000 tons of coal yearly, and the public stores which it has established at its plants purchase 8,000,000 paper pesos worth of general merchandise annually. It produced 340,000 metric tons of nitrate during 1917, 10 per cent of the total amount manufactured during the year. In connection with its nitrate business, the company has built up a large general import and export business, for which it maintains a fleet of four tugs and about a hundred barges at Antofagasta.

Compañía Salitrera El Loa owns about 14,000 acres of land in the Antofagasta district about 95 miles from the coast on the Antofagasta and Bolivia Railroad. It has seven oficinas and produced nearly 212,000 tons of nitrate during 1917. Compañía Salitrera El Boquete has two oficinas located in the Antofagasta district and produced 94,000 tons of nitrate in 1917. Compañía Salitrera Lastenia, also located in the Antofagasta district, has two oficinas and produced 79,000 tons of nitrate during 1917. Compañía de Salitre y Ferrocarril de Agua Santa owns six oficinas in the Tarapaca district and manufactured 55,000 tons of nitrate in 1917.

Important Foreign Companies

The 1917 statistics show eight English companies whose annual production of nitrate amounted to over 50,000 metric tons. The combined output of these companies represented over 60 per cent of the total quantity of nitrate manufactured by English firms during that year.

There are four German nitrate firms. These companies are equipped to produce considerable quantities of nitrate, but were forced to close many of their plants during the war, and, therefore, their 1917 production does not represent their normal output. Compañía Salitrera H. B. Sloman owns four oficinas in the Tocopilla district, two of which were open in 1917 and produced 58,000 tons of nitrate. Compañía Salitrera Alemana owns four oficinas in the Taltal district, only one of which was operated during 1917, producing 42,000 tons of nitrate. Salpeterwerke Gildemeister A. G. owns three oficinas in the Tarapaca district, all of which were operated during the year; their total output was 50,000 tons. Salpeterwerke Augusta Victoria A. G. owns only one oficina. This oficina is located in the Antofagasta district and produced 10,000 tons of nitrate during the year.

The Grace Nitrate Co. and the Du Pont Nitrate Co. are the only American companies producing nitrate in Chile. The Grace company owns a well-equipped oficina in the Tarapaca district where it employs more than a thousand men. The company produced 42,000 tons of nitrate during 1917, all of which was sent to the United States. The Du Pont company has one oficina in operation in the Taltal district and is building a second in the Tarapaca district. Its nitrate production for 1917 was 35,000 metric tons.

The firm of Baburizza, Lukinovic y Cia. was founded by two members of the Slavic colony in Chile and one Chilean, and might be considered Slavic, although it is registered in Chile. This company owns three oficinas and about 69 sq.km. (1 sq.km. = 0.386 square mile) of nitrate land in the Antofagasta district. It employs 2,200 men at its nitrate plants and produced 123,000 tons of nitrate during 1917.

Markets for Chilean Nitrate

The market for nitrate steadily increased and Chile's profits from the exploitation of this natural monopoly increased proportionately until the beginning of the war, when the European demand for nitrate fertilizers practically ceased. Fortunately for the nitrate producers and for Chile, however, the Allies soon found that they needed this product for the manufacture of high explosives; and needed it so badly that they were willing to pay high prices, allocate shipping space to carry it from Chile to the United States and Europe, and furnish the necessary supplies to the producers in Chile; as a result, the intense depression which had begun with the declaration of war was quickly succeeded by an unparalleled prosperity.

TABLE III. CHILEAN NITRATE PRODUCTION AND EXPORT 1909–1918

Year	Production—Short Tons	Production—Metric Tons	Exports—Short Tons	Exports—Metric Tons
1909	2,322,057	2,110,961	2,348,454	2,134,958
1910	2,711,957	2,465,415	2,569,535	2,335,941
1911	2,773,125	2,521,023	2,694,467	2,449,515
1912	2,844,435	2,585,850	2,742,390	2,493,082
1913	3,049,479	2,772,254	3,012,173	2,738,339
1914	2,709,692	2,463,356	2,031,461	1,846,783
1915	1,930,820	1,755,291	2,225,733	2,023,394
1916	3,204,182	2,912,893	3,278,250	2,980,227
1917	3,304,435	3,004,032	3,053,918	2,776,289
1918	.....	.....	3,256,097	2,960,088

The steady increase of the normal pre-war demand

for Chilean nitrate, the depression occasioned by the outbreak of the war, and the subsequent recovery are all reflected in Table III, showing the annual production and exports for the 10-yr. period 1909-1918.

The cessation of hostilities in Europe brought to a sudden and complete halt the need of nitrate for ammunition manufacture and precipitated a period of depression similar to that of 1914. The decline in the market necessitated the closing of a considerable number of the oficinas and the curtailment of production at others; quotations of nitrate stock slid steadily downward; the efforts of the association of producers to maintain selling prices partially failed and they were forced to yield bit by bit in order to sell even a portion of the nitrate stocks rapidly accumulating on the Chilean coast.

Table IV, giving the comparison of nitrate production, exports and stocks in Chile, by months, for 1918 and 1919, shows the difficulties which this industry has been experiencing. The figures are unofficial estimates and the amounts are given in Spanish quintals (one Spanish quintal = 101.4 lb.), the commercial unit of measure for nitrate.

TABLE IV. COMPARATIVE MONTHLY PRODUCTION, EXPORT AND STOCK OF CHILEAN NITRATE, 1918 AND 1919

	Production		Exports		Stocks Remaining in Chile	
	1918	1919	1918	1919	1918	1919
Months	Quintals	Quintals	Quintals	Quintals	Quintals	Quintals.
January...	5,702,618	4,276,498	4,022,345	1,308,951	20,866,273	20,619,547
February..	4,935,804	3,396,211	3,943,769	952,159	21,858,308	23,063,599
March....	5,277,224	3,264,899	4,722,787	963,264	22,412,745	25,365,234
April.....	5,178,797	3,067,362	5,099,754	738,786	22,491,788	27,693,810
May.....	5,295,229	3,084,390	6,385,749	403,669	21,401,268	30,374,531
June.....	5,262,212	2,832,165	5,448,815	795,342	21,214,665	32,411,354
July.....	5,080,070	2,532,632	6,591,953	450,931	19,702,782	34,493,055
August...	4,868,416	2,376,563	6,036,664	1,236,509	18,534,534	35,633,109
September	4,612,448	2,269,619	5,334,556	960,619	17,812,426	36,942,109
October...	5,334,339	2,538,468	7,505,686	3,740,247	15,641,079	35,740,330
November.	5,212,752	2,714,461	5,009,261	2,085,739	15,844,570	36,369,032
December.	5,412,855	(a)	3,355,235	6,359,074	17,902,190	(a)

(a) Statistics not yet available.

Chief Markets for Chilean Nitrate

The United Kingdom, Germany and the United States were the chief markets for Chilean nitrate before the war, the three together taking approximately five-sixths of the total exports during 1912 and 1913. France, Belgium and Holland ranked first among the lesser markets. The statistics of the war years are of relatively little value in gaging the future demand in any country engaged in the European war: Germany and Belgium, formerly good markets, were unable to import any nitrate; the United States, France and Italy increased their imports, but used most of it for ammunition manufacture. From the point of view of the dealer who wishes to estimate the future demand for nitrate, perhaps the most significant development of the years 1917 and 1918 is the marked increase of nitrate exports to Japan.

Table V shows the exports of nitrate from Chile by countries of destination for the pre-war years 1912 and 1913 and the war years of 1917 and 1918.

TABLE V. EXPORT OF CHILEAN NITRATE BY COUNTRIES OF DESTINATION

Countries of Destination	1912 Metric Tons	1913 Metric Tons	1917 Metric Tons	1918 Metric Tons
United Kingdom.....	994,625	1,004,979	756,902	823,269
Germany.....	565,722	629,298	.....	.....
United States.....	484,902	630,790	1,512,577	1,962,552
France.....	108,880	121,472	139,866	20,304
Belgium.....	92,929	118,690	.....	.....
Holland.....	98,747	100,379	43,997	.....
Italy.....	9,306	10,684	67,961	6,906
Japan.....	21,707	28,342	50,773	47,512
All other.....	116,264	93,705	204,213	99,545
Total.....	2,493,082	2,738,339	2,776,289	2,960,088

After the signing of the armistice, the United States Government no longer needed the nitrate purchased for war purposes and transferred the amount on hand from the War Department to the Agricultural Department for distribution to the farmers. This amount, plus a considerable quantity already held by the Agricultural Department, was sold at cost. As long as these stocks were available at low prices, there was little chance for the sale of privately held nitrate, but the last of this supply was disposed of in the spring of 1919 and subsequently all Government restrictions on nitrate imports were removed. The nitrate dealer has a free market once more and, what is of equal importance in his estimation, the Government plants for the manufacture of synthetic nitrate have been closed. Imports of nitrate of soda into the United States for the year 1919 were 407,459 long tons, about 65 per cent of the 1913 imports.

Apparently a relatively small proportion of the nitrate imported into the United States is used for fertilizer purposes. According to the War Trade Board, about 40 per cent is ordinarily used in the manufacture of explosives, 13 per cent for fertilizer, and the remainder for making sulphuric acid and for miscellaneous purposes. The Department of Agriculture reports that 564,000 tons was imported during 1914, of which amount 162,000 tons, about 29 per cent, was used for fertilizer purposes.

European Sales Restricted During 1919

About 80 per cent of the nitrate imported into Europe is ordinarily used for fertilizer purposes. It is said that there was an active demand for these fertilizers last year, but government restrictions, accentuated by the lack of shipping space, greatly restricted sales, especially during the early part of the season when the demand was strongest.

Great Britain had contracted for 680,000 tons of nitrate shortly before the signing of the armistice, practically all of which became available for ordinary market uses, and import restrictions were not removed until the major part of these government stocks had been disposed of. Since the middle of May, when government restrictions were finally removed, imports have been greatly hampered by the lack of available tonnage.

Germany has been unable to import nitrate because of the continuance of the blockade, but it seems unlikely that it would have been able to do so anyway, as at the present depreciated value of the mark, the selling price of nitrate fertilizers would be prohibitively high.

The reduction of acreage under cultivation in France and Belgium has somewhat curtailed the demand for nitrate fertilizers, but it is stated that consumption would have been nearly double what it was during the first half of the year had it not been for the congestion at the ports, the disintegration of the interior transport service, and government restrictions.

Chile has been greatly alarmed by this depression in the market for nitrate and by rumors hinting that nitrate was to be supplanted in Europe and America by two rivals, namely, sulphate of ammonia, a byproduct of coke, and synthetic nitrate produced by electric fixation of atmospheric nitrogen. To fully appreciate this alarm, it is essential to comprehend how dependent the nation is upon this one export.

Chile buys the bulk of its manufactured products abroad and pays the bill with the raw products exported, nearly 80 per cent of whose value is represented

by nitrate sales. Therefore the value of the Chilean peso abroad is directly affected by the market for nitrate, and nearly all private business in Chile is indirectly dependent on the nitrate industry.

Government Aid to Producers

The vital importance of the nitrate industry to the Chilean Government is graphically illustrated by the following facts: For the period 1901-1917 the export duties on nitrate and its principal byproduct, iodine, constituted 62 per cent of the total revenue received; during 1913, the last pre-war year, they constituted 57 per cent of the total revenue; and during 1917, the last year for which these statistics are available, they formed 65 per cent of the total. The government cannot afford to allow the exports of nitrate to decline nor can it afford to have the 50,000 laborers ordinarily employed in the nitrate fields idle.

During the depression of 1914 the government arranged to make temporary loans to the producers in order that they might not have to close their plants. Under this system the nitrate companies desiring them were issued government bonds, which they were at liberty to sell in the open market. These advances were to be guaranteed on nitrate stocks and to be refunded plus the accrued interest when said stocks should be sold. These arrangements have been continued up to the present time, the companies now being allowed to receive not to exceed four paper pesos for each Spanish quintal of nitrate delivered at the port of embarkation and not to exceed three pesos for each Spanish quintal stored at the oficinas. From August, 1914, to December, 1918, government loans to producers amounted to 103,946,000 paper pesos and reimbursement of these loans to 98,570,000 paper pesos. Loans during January, 1919, amounted to 9,561,000 paper pesos.

Further evidence of the government's interest in the welfare of the nitrate industry is afforded by the recent appropriations to the newly established industrial school for nitrate research; by the recognition accorded the scientific society lately formed by a number of Chilean and English nitrate companies; and by two plans recently discussed in Congress. The first of these plans, to centralize sales under government control, has been severely criticized; the second, to alter the basis of the nitrate tax, has been discussed several times but no definite action taken. The nitrate tax, as now imposed, is a fixed amount, 2s. 4d. ($0.568) per Spanish quintal of nitrate exported, and the cost of production varies according to the nitrate content of the raw material exploited and according to the size and efficiency of the reducing plant, wherefore some companies realize much larger profits than others. Under the plan now being discussed the tax would be levied on the profits of the companies rather than on the nitrate exported.

Protective Association Formed by Companies

During the recent crisis a second attempt has been made to organize the nitrate producers into an association which shall limit production and centralize sales, the object being to allow only as much nitrate to be exported as the consuming markets can absorb at a price high enough to afford reasonable profits to the producers. The first association was formed in 1901 and ceased to exist in 1909 because of a disagreement concerning production allotments to certain companies. The present association is the outgrowth of the former association and the Nitrate Propaganda Committee organized by the English companies about 1889 and later known as the Asociacion de Salitre de Propaganda. This association has had headquarters in Chile and has had two distinct prerogatives: To keep a complete statistical record of the progress of the nitrate industry, and to increase the world market for nitrate through the education of the public as to its uses. For this latter purpose propaganda committees have been maintained in France, Germany, Belgium, Holland, Spain, Italy, the United States, Japan, Egypt, Cuba, Australasia, England and Wales.

The directors of this association felt the necessity of forming an organization which would have some control over the entire industry, that this organization should consist of the producers, and that it should be free from any sort of government control. They therefore appointed a committee to study the situation and draw up a plan for such an organization. This plan was presented and accepted at a meeting of the producers held in January, 1919.

Work of the Association

All the Chilean and English producers are now members of this association, and it is reported that the four German companies are to be admitted in the near future. The two American firms, the Grace Nitrate Co. and the Du Pont Nitrate Co., have not joined the association.

The duties of the association may be briefly summarized as follows:

1. To spread nitrate propaganda, commercial and scientific, throughout the world market.
2. To keep a statistical record of the industry.
3. To regulate exports and control production within certain general limits.
4. To fix selling prices periodically to accord with conditions governing the market and factors governing the cost of production.
5. To establish nitrate stocks at convenient ports.
6. To study and encourage new methods of refining and mining.

The association has followed the established custom of selling nitrate f.o.b. Chilean ports. Prices are quoted in shillings and pence per Spanish quintal of 101.4 lb. The association could not hope to sell nitrate at 13s. ($3.163) per quintal for ordinary, or 95 per cent nitrate, and 13s. 6d. ($3.285) for refined, or 96 per cent, the prices at which the Allied Governments were purchasing it at the close of the war, but attempted to fix a selling price of 10s. 1d. ($2.454) for ordinary and 10s. 4d. ($2.514) for refined, a price above the average for any year prior to 1917. As the report of sales issued in October, 1919, shows, however, it has not been able to maintain this price, its average selling price for nitrate sold up to October having been 9s. 0.5d. ($2.20) for ordinary and 9s. 4.2d. ($2.28) for refined, and for nitrate to be delivered between October and March, 1920, having been 9s. ($2.19) for ordinary and 9s. 3d. ($2.25) for refined. At these average prices, it had disposed of 17,358,000 quintals of ordinary and 866,000 quintals of refined up to October, and had contracted for 16,500,000 quintals for future delivery.

Encouraged by the slight improvement in the market, the association raised its price in October to 9s. 7d. ($2.33) per quintal for delivery up to Dec. 15 and 9s. 9d. ($2.37) for later delivery up to June 30, 1920. Between October and December prices were gradually increased until in December nitrate for immediate delivery was sold at 9s. 7d. ($2.33) and for future delivery from 10s. 6d. to 12s. ($2.56 to $2.92)

The profits of the last few years have afforded many of the producers an opportunity to fortify themselves against this anticipated period of depression. The following statistics, compiled from recently published reports, of some of the more important English and Chilean companies illustrate to what extent they have taken advantage of this opportunity.

The fourteen English companies which close their year in December had a total capitalization of £4,189,000 at the end of 1918 and £404,900 outstanding in debentures, against which they had £1,216,359 in reserves and £786,573 in their carry forward accounts. They had distributed £592,275 in dividends for the year, an average of 14.1 per cent, and had added £155,000 to the reserves and increased their carry forwards. (The value of the pound sterling is $4.8665 at normal exchange.)

La Compañía de Salitre de Antofagasta, the largest nitrate producing company, made a profit of 22,305,520 paper pesos for 1918, out of which 11,520,000 was distributed in dividends, 10,000,000 added to funds for exploitation and amortization of property, and the remainder to a contingency fund. The company is capitalized at 16,000,000 paper pesos, has a reserve fund of 2,000,000, a contingency fund of 2,674,955, a fund of 32,000,000 for exploitation and amortization of property, an insurance fund of 2,500,000, and a fund of 2,000,000 paper pesos to provide for fluctuation in exchange.

Compañía Salitrera El Loa, another large Chilean company, made a net profit of £450,314 during 1918, out of which £227,500 was distributed in dividends, £200,000 placed in the fund for amortization of oficinas and land, and the balance placed in the dividend fund.

Compañía Salitrera Lastenia made a net gain of £184,197 during 1918, out of which £124,800 was distributed in dividends, and the remainder placed in the dividend fund. This company is capitalized at £624,000, has a reserve fund of £20,000, a fund of £8,029 for operation, a fund of £14,024 to provide for the fluctuations of exchange, and a dividend fund of £75,795.

Outlook for Future Reassuring

According to the representatives of the association abroad the prospective demand for nitrate fertilizers for use on next year's crop is excellent. The largest problem is that of ocean transportation; indeed so serious is this one factor that the sales for some time to come will probably be limited by the available shipping space and the prevailing freight rates. Uncertain exchange and disturbed political and economic conditions in Europe will tend indirectly to reduce consumption also.

The association reports the present outlook decidedly encouraging, although no spectacular recovery is expected. It is estimated that exports for the present nitrate year (July 1, 1919, to June 30, 1920) will not exceed 30,000,000 Spanish quintals (about 1,400,000 metric tons).

The educational work in the application of Chilean nitrate to the soil has been successfully carried on since the formation of the original association of producers and the resultant demand is expected to continue for a long time to come.

If Chilean nitrate is ever displaced to any great extent in the fertilizer field the process will be so slow as to work little hardship on the producers. Such replacement certainly can never keep pace with the rate of increase in demand for nitrogen fertilizers.

Calibration of an Optical Pyrometer

By W. E. Forsythe

AN OPTICAL or other pyrometer is calibrated by finding the relation between the reading of the scale, whatever that may be, and the temperature of the standard source with which it is compared. In the disappearing-filament type of optical pyrometer the quantities involved are the current through the pyrometer filament and the temperature of a black body when the filament as observed through the eyepiece apparently matches in brightness the black-body image located in the plane of the pyrometer filament.

The direct way to calibrate the pyrometer is to have a black body that can be operated at various known temperatures over the entire range that it is desired to use the pyrometer. This is always very difficult and sometimes impossible. The main trouble is to get a black body that will stand the high temperatures and at the same time it is difficult to get a satisfactory method of measuring these temperatures. Standard black bodies are seldom operated at a temperature higher than that of melting palladium (1,828 deg. K.).

Thermocouples that have been operated for any length of time at this temperature are not reliable in their indications. For the above reasons, when calibrating for temperatures above the range of thermocouples, use must be made of standard melting points or another optical or a radiation pyrometer. There are not many metals that can be conveniently used for this purpose. The two that are most commonly employed are gold (1,336 deg. K.) (deg. K. indicates degrees Kelvin, i.e., absolute Centigrade) and palladium (1,828 deg. K.). There are no metals with melting points between these two that can be used without much trouble due to oxidation.

An optical pyrometer can be calibrated from a black body held at a particular temperature[1]. Since the black body thus used is to be the standard of reference, a standard temperature, that is, one determined by means of a standard melting point, is generally chosen. A very good temperature for such work is that of melting palladium, or the palladium point. There are three reasons for the choice of this point. In the first place, it is about as high a temperature as a platinum-wound furnace can be operated. In the second place, this temperature is about as high as the pyrometer filament will stand if it is to have a long life. In the third place, the temperature of melting palladium is very well known in terms of the laws of radiation and the temperature of melting gold.

Reduction of Apparent Radiation

To calibrate an optical pyrometer from a furnace held at a particular temperature it is necessary to have some means such as a rotating sectored disk (to be described below) or an absorbing glass of known transmission for cutting down the apparent brightness of the incident radiation. If readings are made of the current through the pyrometer filament for an apparent brightness match with a rotating sector or an absorbing glass of known transmission between the pyrometer lamp and the standard black body, there will be obtained a measure, in terms of a current through the pyrometer filament, of a brightness that is some known factor of that of the standard black body at the standard tempera-

[1] C. E. Mendenhall, *Phys. Rev.*, vol. 33, p. 74 (1911).

ture. If monochromatic radiation is used, it is easy to calculate the temperature, T_2, of the black body corresponding to this measured brightness, that is, to this current through the pyrometer filament from T_1, the standard temperature, by the following formula derived from Wien's equation:

$$\log R = \frac{c_2 \log e}{\lambda}\left[\frac{1}{T_2} - \frac{1}{T_1}\right] \qquad (1)$$

where R is the transmission of the sector, temperatures on the absolute Centigrade scale, and λ the wave-length used. If the measurements are made with a red glass in the eyepiece, the temperature that would correspond to this fraction of the brightness of the standard black body can be calculated just as before, excepting that in this case the effective wave-length of the red glass for this temperature interval is to be used. By using a number of such sectors, points can be obtained for a curve showing the relation between the temperature and current through the pyrometer filament. In Table I is given the transmission value of a number of sectors and the apparent temperatures, T_2, that would be obtained by their use in connection with a black body held at the temperature of melting palladium.

TABLE I.

Temperatures corresponding to different percentages of the radiation from a black body held at the temperature of melting palladium (1,828 deg. K.) using red glass with an effective wave-length which varies as is shown in column 2. C_2=14,350 μ deg.

Transmission of Sector*	λ_e*	T_2 Deg. K.
0.749	0.6652μ	1785
.499	.6653	1727
.2443	.6655	1632
.0830	.6657	1509
.0336	.6658	1426
.01668	.6659	1356
.00542	.6662	1267

*Last digit in this column approximated.

Use of Standardized Filament

It is very troublesome to operate a standard black body every time it is necessary to calibrate an optical pyrometer. Much time can be saved if a tungsten lamp with a filament of suitable size is standardized so as to have the same brightness for a particular part of a filament, when observed with the optical pyrometer, as the standard black-body furnace for one or more definite temperatures. Such standard lamps with single-loop wire filaments have been made, calibrated and used in this laboratory for this purpose for several years. The bend in the wire was made somewhat sharp and the center of this loop used as a point of reference. This method has recently been employed by a number of the research laboratories of the country using lamps calibrated at several currents for temperatures between 1,200 and 2,000 deg. K.

For the highest accuracy the tungsten lamp that is to be used for calibration purposes should be standardized with an optical pyrometer using a red glass which is the same as that on the pyrometer to be compared, or correction should be made for the difference. If the effective wave-lengths are known, this correction can easily be made.[2] For practical purposes, however, if similar red glasses are used the error will be quite small.

Tungsten filaments have been found to depart very markedly from Lambert's cosine law in their radiation.[3] To avoid error due to this cause, care must always be taken in determining the temperature of circular filaments to measure the brightness of the central part of the filament. For this reason, the pyrometer filament should always be parallel to the background filament. This, of course, requires that the pyrometer filament be much smaller than the image of the background filament used as a standard.

A ribbon tungsten filament with some mark to indicate the exact spot sighted upon is sometimes used as a standard background against which to calibrate a pyrometer filament. The ribbon filament does not require as much magnification as the wire filament. A commercial form of the disappearing-filament pyrometer which has a small magnification can be calibrated, using such a ribbon filament, providing an extra lens is used between it and the pyrometer so as to give a large image of the filament. If a lens is used corrections must be made for its transmission, or the background lamp must be calibrated by means of the standard pyrometer with the lens before the lamp. The transmission of a lens is measured in much the same manner as is the transmission of a piece of absorbing or other glass. The method generally employed is to form an image with the lens whose transmission is being measured and then, taking care to see that the lens is not limiting the beam, to measure the brightness of this image and compare this brightness with that of the standard source as observed directly.

If transmissions are measured with the pyrometer, it is necessary to have it calibrated for relative brightness rather than for temperature. If a number of calibrated rotating sectors are available, this is very easily done. It is only necessary to find the currents through the pyrometer filament for apparent brightness matches against a standard source when the different sectors are used and plot a curve between relative brightness as given by the transmission of the sectors and the current.

If it is not possible to do this in an industrial plant, such work can always be done in a standardizing laboratory. From the transmission of the lens thus determined, the correction to the temperature can be calculated by means of equation (1), where in this case R is the transmission of the lens.

A ribbon-filament lamp and lens combination has been used to calibrate a Wanner type of optical pyrometer. In this case, the image of the filament was focused on the slit of the pyrometer and readings made by obtaining the relation between the scale of the pyrometer and the temperature of the ribbon filament, corrected, of course, for the transmission of the lens.

Approximate Values by Interpolation

If a rotating sector or an absorbing glass of known transmission is used between the source being investigated and a calibrated pyrometer lamp, the calibration of this pyrometer with the sector or absorbing glass can be extended above the standard black body. In this case, the temperature is to be calculated from the temperature corresponding to the current through the pyrometer filament and the transmission of the sector or absorbing glass used by means of equation (1) above, excepting that for this computation, R is the reciprocal of the transmission of the sector or glass and then T_2 will come out greater than T_1. A very convenient method is to work out such extrapolated temperatures for the various sectors, as shown in Table II.

In this table are given a series of extrapolated temperatures using different sectored disks. In column 1

[2] *Gen. Elec. Rev.*, vol. 20, p. 749 (1917).
[3] Worthing, *Astrophys. Jour.*, vol. 36, p. 345 (1912).

are given the initial temperatures, that is, the ones that would correspond to the pyrometer reading without any sector, and in the other columns are given the extrapolated temperatures corresponding to the same pyrometer readings when the sector whose transmission is given at the head of the column is used between the pyrometer lamp and the source studied. When these extrapolated temperatures are plotted against the initial

TABLE II.

Initial temperature	Extrapolated temperatures, using red glass, for various sectors with transmissions as given. $C_2 = 14{,}350\mu$ deg. Transmission of Sectors.				
	0.499*	0.2443*	0.0830*	0.01664*	0.00542*
Deg. K.	Deg. K.	Deg. K.	Deg. K.	Deg. K.	Deg. K.
1200	1249	1303	1398	1555	1692
1300	1357	1421	1530	1727	1898
1400	1466	1541	1671	1908	2117
1500	1577	1663	1815	2098	2353
1600	1687	1787	1963	2298	2608
1700	1799	1912	2115	2509	2883
1800	1911	2090	2272	2735	3182
1900	2024	2169	2432	2963	3507

* Last digit approximated

temperatures the extrapolated temperatures corresponding to any pyrometer reading can be obtained. A like set of curves can be made for a series of absorbing glasses of known transmission. Such curves can then be employed with any pyrometer having the same red glass, providing the same sectors or absorbing glasses are used.

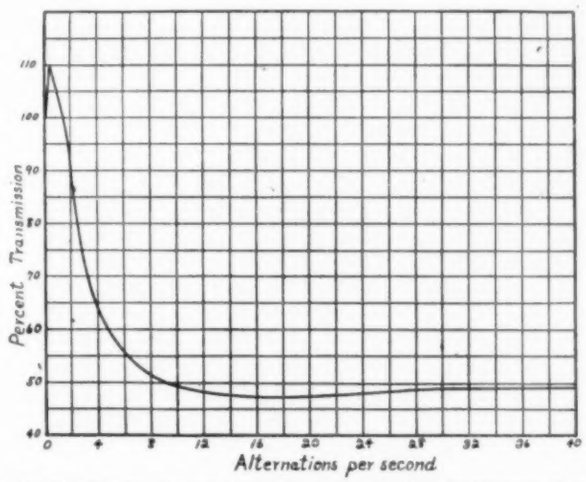
Sectors and Absorbing Glasses

A few words might well be said concerning the sectors or absorbing glasses that are used in calibrating the pyrometer or in extending the scale beyond that for which the pyrometer is calibrated directly. The list of sectors (about 35 cm. in diameter) given in Table I have been found satisfactory for temperature work The transmission of the sectors or absorbing glasses must be known to somewhat better than 1 per cent for accurate work. The sector must rotate at such a speed that no flicker is noticeable. To accomplish this, the alternations must be at least 30 to 40 per sec. This is for the condition where the open and closed spaces of the sector are about equal in size. If there is a very great difference between the open and closed parts of the sector, as for instance in the case of the 2-deg. sector with two 1-deg. openings, the speed must be higher. If the motor available will not rotate the sectors fast enough when there is but one opening and one closed part, it is often a great help to make more open spaces. A good plan is to have six openings, which will reduce the necessary speed considerably. For a sector as small as two having a 1-deg. opening this is impossible without making the sector too large, because if the sector opening is too small there is danger of an error due to diffraction. In this case, with a sector the size of the one here used, it is necessary to have a motor that will rotate it something like 3,500 r.p.m.

In the accompanying figure are shown the values found for the transmission of a 180-deg. sector as a function of the speed in alternations per second. This transmission was measured with the optical pyrometer. It can be seen, as shown in the curve, that the value found is constant and equal to the transmission of the sector for alternations above about 30 per sec., but below that the transmission at first becomes smaller and then larger, and an apparent transmission of over 100 per cent is obtained for a speed of alternations of about 1 per sec. The transmission, of course, approximates 100 per cent for zero speed.

The values found for the transmission for speeds corresponding to alternations between 10 and 30 per sec. is due to a flicker which bothers the observer. It might be that another observer would get slightly different values for the transmission for such speeds. For speeds slower than 10 alternations per sec. the observer attempts to make settings when the open part of the sector is passing before the opening. There is a very great flicker and settings are attempted using only the bright part. The value found for extremely low speeds is due to the apparent over-shooting of the brightness of the source when viewed only for the short time as compared with the pyrometer filament, that always has about the same brightness.

If the sector has a long opening measured in the direction of the radius, care must be taken to always use about the same part of this opening. This is to



TRANSMISSION OF 180-DEG. SECTOR (TRANSMISSION 0.492) AS A FUNCTION OF THE SPEED OF ROTATION IN ALTERNATIONS PER SECOND

avoid error due to the fact that the radial sides of the openings may not be straight or may not be in a radial direction.

Absorbing glasses are not, in general, neutral tint. However, this is not necessary. All that is needed is to have a glass whose spectral transmission is nearly enough independent of the wave length to enable different observers to make brightness comparisons with very nearly the same results. The absorbing glass must be mounted in such a manner that the exact part that was calibrated is always used. This is because even the best absorbing glass is apt to vary in its transmission from point to point. Mounting must also be such that the beam of light will always make the same angle with the absorbing glass. Most absorbing glasses, when used with the red glass of the pyrometer, have a transmission that depends upon the distribution of energy, that is, the temperature of the source. This, of course, must be known and allowed for in accurate work.

Nela Research Laboratory,
Cleveland, Ohio.

Export Embargo on Gum Copal in Sierra Leone

Consul W. J. Yerby has reported from Dakar, Senegal, that an order in council of April 26, 1920, prohibits the exportation of gum copal from that colony for a period of three years beginning Sept. 30, 1920.

Synopsis of Recent Chemical & Metallurgical Literature

Magnesite Refractories.—From the scattered articles appearing in the technical press of the last generation and a survey of the salient facts in the entire field pertaining to the occurrence, preparation and properties of magnesite for refractory use V. SPOTTS MACDOWELL of the Harbison-Walker Refractories Co. and RAYMOND M. HOWE of the Mellon Institute have prepared an exhaustive paper on the subject which appears in the March, 1920, issue of the *Journal* of the American Ceramic Society. The development of this refractory began as early as 1860 in Europe for use in the bessemer process and has progressed to the production of 131,924 tons of calcined material in 1918. Iron oxide is now used to secure the proper sintering and bonding properties and is incorporated at extremely high temperatures.

The principal crystalline deposits are found in Austria-Hungary, Washington State and the Province of Quebec. Cryptocrystalline or amorphous beds occur in Greece, California, India, the Transvaal, Venezuela and the Cedros Islands, off the coast of Mexico.

The preparation in Europe and California involves largely burning in bottle-shaped kilns, while Canadian and Washington producers employ the rotary type. In the small ware magnesia crucibles are sometimes made by machining the brick. Linings for graphite laboratory crucibles used in preparing ferro-alloys are molded in place by tamping calcined magnesia around a wooden core. The core is removed, the lining dried, and burned in a carbon resistance furnace to a temperature above 1,755 deg. C.

Magnesia brick is commonly made from a dead-burned magnesite containing 4.5 to 8 per cent Fe_2O_3. Bonding material is not ordinarily used in American practice. The magnesite is mixed in a wet pan with a small amount of water and moldings are made in power press. After drying in tunnel driers rectangular down-draft kilns are used for burning and the bricks are then cooled slowly to avoid cracking.

The properties of the brick are given in this paper as to color, texture, specific heat, microscopic structure, chemical composition, crushing strength, thermal expansion, hydration and slaking.

Carbon acts on magnesia at high temperatures to cause shrinkage fitting and a black soot consisting of an intimate mixture of magnesia and carbon deposits on the walls of the electric furnace. The reaction is generally thought to occur as follows:

$$\underset{\text{solid}}{MgO} + \underset{\text{solid}}{C} = \underset{\text{vapor}}{Mg} + \underset{\text{vapor}}{CO}$$

The vapors have a reversible reaction on the cool walls of the furnace to make this sooty mixture. The temperature of the reaction varies from 1,450 to 2,030 deg. C. as recorded by different observers.

The authors conclude with the following: "The field for investigation of the properties of dead-burned magnesite and magnesia brick, and of the possibilities of improving their commercial value, offers a number of attractive problems. The influence of texture and composition of the raw magnesite, and the effect of added impurities upon the properties of the burned product, are not thoroughly understood. How the change from amorphous magnesia to periclase crystals may be brought about most economically and completely, and the crystals bonded together to form a brick which will be strong at furnace temperatures, with minimum shrinkage and tendency to spall, are questions deserving much careful study."

A large selected bibliography of magnesite and magnesite brick dating from 1873 is appended to the paper.

Supplementing the Natural Gas Supply With Byproduct Coke-Oven Gas.—The rapid increase in the demand for natural gas, coupled with the exhaustion of wells in districts that owe an important part of their industrial development to the availability of this valuable fuel, presents a problem which already demands serious attention. At the Buffalo meeting of the Natural Gas Association, C. J. RAMSBURG pointed out the opportunities afforded by the byproduct coke industry in the way of supplementing our natural gas supply. The paper was published in full in *Gas Age*, vol. 45, p. 456; May 25, 1920.

Of the high-grade artificial gases available with present methods of manufacture, only two, coal gas and carburetted water gas, deserve serious consideration. A very important factor in the cost of carburetted water gas is the price of gas oil, and this has increased to such an extent as to make any large-scale competition of carburetted water gas with coal gas out of the question. Moreover, we are beginning to face a condition of oil shortage quite analogous to our natural gas shortage. This condition is seriously embarrassing the manufacture of carburetted water gas in many plants and has already led to the erection of a number of coal gas plants.

The gas produced by heating coal in retorts is usually referred to as coal gas, but the byproduct coke oven is capable of furnishing a high-grade gas which is just as truly coal gas as that made in the retort. Furthermore, the byproduct coke oven possesses many advantages over the gas retort for the large-scale manufacture of coal gas: The coke is of superior quality; the yields of ammonia and benzol are greater; the coal and coke are handled mechanically in relatively larger masses; the heating efficiency is greater; the life of the plant is longer. The annual consumption of coke-oven gas for domestic and industrial purposes (outside of iron and steel plants and other establishments with which the byproduct coke ovens are directly connected) is about 40,000,000,000 cu.ft.

To those who are familiar with the enormous rate at which natural gas is being produced and consumed, it might seem that any artificial source of supply must be small in comparison. However, it is estimated that the average normal consumption of coal for the manufacture of coke during the next five years will be approximately 86,000,000 net tons per year. If all of this coal were coked in byproduct ovens, we should have a gas yield of 10,500 cu.ft. per ton, or a total gas production of 900,000,000,000 cu.ft. of gas per year, which is probably a greater volume than the present annual production of natural gas. This figure represents the maximum possible gas production in connection with coke manufactured at the present average rate. We have not, however, got to the point where every ton of coke will be made in byproduct ovens.

Of the 86,000,000 tons of coal used for the manufacture of coke, it may be estimated that, during the next five-year period, 46,000,000 tons will be coked per year in byproduct ovens, with a total gas production of 480,000,000,000 cu.ft. The waste of gas from beehive ovens will continue at a rate of 420,000,000,000 cu.ft. per year.

One of the most important factors affecting the availability of coke-oven gas for use outside of the plant is the substitution of a low-grade gas for heating the ovens. Producer gas or blast-furnace gas is well adapted to this purpose, thus releasing the entire output of richer oven gas for distribution. The advantages of producer gas for heating the ovens may be summed up as follows:

First, the producers may be fed with small sized coke unsuitable for use in the blast furnaces. Here the equipment is simple and comparatively inexpensive, especially with respect to the gas-cleaning apparatus. The amount of coke required for the producers is 12 to 14 per cent of the weight of the coal charged into the ovens. This amount may readily be obtained by properly screening the oven product, leaving a high-grade, thoroughly clean coke for the use of the blast furnaces.

Second, where there is available a cheap coal, having fair coking qualities, but unsuitable for the manufacture of blast-furnace coke, such coal may be coked in some of the byproduct ovens, delivering thereby its byproducts and furnishing sufficient coke for the operation of the gas producers.

Third, where there is available cheap low-grade coal unsuitable for making blast-furnace coke, such material may be used directly in the gas producers.

Fourth, byproduct producers may be installed using any coal available. The equipment and operation of byproduct producers fits in very well with that of the byproduct coke plant, and the combination, costing much less than separate plants, offers many possibilities for increased economy and valuable returns. Heretofore, on account of coal values, the employment of byproduct gas producers has been more extensive in Europe than in America, and here, with the present appreciation of coal values, their development presents enormous possibilities.

As the demands of the natural gas industry for a supplementary supply of high-grade artificial gas outgrow the possibilities afforded by such byproduct coke plants as are operated in connection with iron and steel plants in any locality, it is certain that additional byproduct coke plants will be erected primarily to meet the needs of the natural gas industry. Much might be saved if it were possible to build the byproduct coke ovens at the coal mines, as has been the general practice in the case of beehive ovens; but this has hitherto seldom been permissible, either because the mines were located too far from the consumers of gas, or because the locations were in districts well supplied with natural gas. With diminishing natural gas supply, the peculiar relations of the natural gas industry with respect to the coal-mining regions of Pennsylvania, Ohio and West Virginia are likely to make it profitable to build byproduct coke ovens at the mines, because many coal mines supplying good coking coal are within easy reach of large natural gas distributing systems into which the coke oven gas could readily be conveyed. With a reasonable price for the gas and with proper methods of coke disposal, such plants can operate with maximum economy. The low price of land at the mines is an important item.

Progress toward the general use of gas as sole domestic fuel must necessarily be slow and depends largely on accustoming people to lower heat value standards. There can be no question that at present, from an economic standpoint, we are working on too high a level as regards the heating value of gas.

It is the opinion of many economists who have studied the problems of conservation and efficient utilization of our fuel resources that the ultimate ideal should be the conversion of all the coke into gas at the byproduct coke plant, so that the plant will supply all of its fuel product in gaseous form. It may be that we are in a transition period that will ultimately end in discontinuing entirely the use of solid fuel for most industrial and for all domestic purposes.

The proposition of gasifying all of the coke produced at the byproduct coke plants leads to the subject of mixed gases, because all of the surplus gas produced from the coke over and above the requirements of the plant for its own steam, power and heating will, in the majority of cases, be mixed with the coke-oven gas before distribution to the consumer. This subject is one of great importance. It has such a wide scope and involves so many subsidiary questions, both economic and technical, that it cannot be adequately treated within the limits of this paper. Attention will, however, be directed to a few leading points.

1. The mixed gas sold to the consumer must have such characteristics with respect to specific gravity and heating value as to meet his purposes satisfactorily without unduly increasing the investment required for his appliances.

2. The question of the rate of heating afforded by the gas is in many cases more important than the total heat units supplied. The rate of heating is, of course, a function of the flame temperature. For example, straight producer gas has been burned in cook stoves, but its flame temperature is so low that it works much too slowly to be practicable.

3. It is very questionable whether it ultimately pays to sell gas containing a large percentage of inert, incombustible constituents for wide distribution. The principle involved is much the same as in the transportation of coal containing high percentages of ash.

4. There are two generally feasible methods for the production of mixed gas at the byproduct coke plant with complete gasification of the coke, viz.:

(a) Gasification of the coke in producers using part of the producer gas to heat the ovens and the remainder to mix with the coke-oven gas. This method would produce per ton of coal over and above plant requirement, 10,500 cu.ft. coke-oven gas of 560 B.t.u. and 75,600 cu.ft. of producer gas of 130 B.t.u., making 86,100 cu.ft. mixed gas of 183 B.t.u.

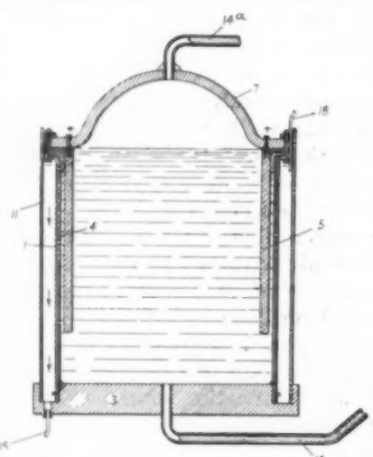
(b) Part of the coke is gasified in producers making sufficient gas to heat the ovens. The remainder of the coke is put into water gas generators and its carbon converted into blue water gas, which is mixed with the coke-oven gas. This method will produce per ton of coal 10,500 cu.ft. coke-oven gas of 560 B.t.u. and 22,600 cu.ft. blue water gas of 300 B.t.u., making 33,100 cu.ft. mixed gas of 383 B.t.u.

Recent Chemical & Metallurgical Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Compressed Ethylene. — Ethylene can be directly compressed to a high pressure, far in excess of that to which acetylene can be safely compressed, and can be stored in cylinders or containers without the use of an absorbent filling and solvent, and without the danger and disadvantages incident to the compression and storage of acetylene. The entire space of the cylinder can, accordingly, be filled with the compressed ethylene. Moreover, since the ethylene is present in a gaseous, rather than a "dissolved" or liquid state, the entire content of the cylinder can be made available, even in the coldest weather, without objectionable lowering of temperature due to evaporation. A cylinder having a cubical capacity of about 0.777 cu. ft. (commonly called a 100 cu.ft. hydrogen or oxygen cylinder) can be safely charged with from 150 to 200 cu.ft. of ethylene. Expressed in terms of cu.ft. ethylene per cu.ft. cylinder capacity, it is easily possible to charge 200 to 250 cu.ft. of ethylene per cu.ft., whereas with hydrogen and oxygen the cylinders contain only about 130 cu.ft. per cu.ft. (1,339,431; ARTHUR A. BACKHAUS, of Baltimore, Md., assignor to U. S. Industrial Alcohol Co.; May 11, 1920.)

Electrolytic Chlorine Cell.—The apparatus consists of: A perforated cylindrical iron cathode, 1, resting in an annular channel in the base member, 3; a cylindrical diaphragm, 4, inside of the cathode; a cylindrical graphite anode, 5; an exterior casing, 11; a dome, 7, bolted to the body of the cell in such a manner as to insulate the anode from the cathode and make the anode and cathode compartments gas tight. Sodium chloride solution enters the cell at the bottom through pipe 14. The products of electrolysis — chlorine, sodium hydroxide solution and hydrogen — are removed through 14a, 15 and 18 respectively. The dome-shaped head permits the level of the electrolyte to rise as the porosity of the diaphragm decreases, thereby insuring an even flow of liquor through the diaphragm at all times irrespective of the degree of porosity of the latter. The dome also serves as a conductor to the graphite anode, doing away with the copper busbar commonly used. (1,342,336; PAUL MCDORMAN, of Niagara Falls, N. Y., assignor to the Electro Chemical Co.; June 1, 1920.)



ELECTROLYTIC CHLORINE CELL

Electrolytic Hypochlorite Cell. — In hypochlorite cells where the hypochlorite is formed near the electrodes, there is a reduction in efficiency due to secondary reactions. At the cathode some of the OCl ions are reduced to Cl ions, while at the anode ClO_3 ions are formed by oxidation. JOHN GERSTLE, of Dayton, Ohio, has designed a cell in which the chlorine and sodium hydroxide are generated separately and then mixed in baffled chambers so that the hypochlorite formed does not come into contact with the electrodes. (1,342,378; assigned to Electro Chemical Co.; June 1, 1920.)

Sulphuric Acid Concentration. — Incrustations of sulphates which form in concentrating sulphuric acid in the cascade system may be removed by passing weak and strong acid through the cascade alternately. The weak chamber acid removes the incrustation left by the strong acid. (1,340,290; JOHN PATTEN, of Baltimore, Md., assignor of one-half to Samuel M. Shoemaker, of Eccleston, Md.; May 18, 1920.)

Sulphuric Acid from Sulphur Dioxide and Selenium Dioxide.—Selenious acid (prepared by treating selenium dioxide with water) will oxidize sulphur dioxide to sulphuric acid according to the equation:

$$SeO_2 + 2H_2O + 2SO_2 \rightleftharpoons Se + 2H_2SO_4$$

Complete elimination of the SeO_2 is assured by repeated treatment with SO_2 at about two atmospheres pressure. The precipitate of selenium is removed by filtration. It may be roasted to form the dioxide again. Tellurium dioxide may be used in the same manner. (1,341,462; PAUL HAESELER, of New York, assignor to the Liberty Laboratories, Inc.; May 25, 1920.)

British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Gallic Acid.—Gallic acid is obtained by heating tannin with an amount of a metallic compound sufficient to effect a substitution of the hydrogen atoms of the carboxyl and hydroxyl groups formed on hydrolysis, and then decomposing the resulting gallate with an acid. An excess of the metallic compound is preferably employed, in order to coagulate the albuminous material. The metallic compounds referred to are the hydroxides, oxides and weak acid salts (e.g., carbonates and acetates) of the alkali and alkaline-earth metals, magnesium, lead, copper and zinc. (Br. Pat. 139,419—1919. NITRITFABRIK AKT. GES., Kopenick, Germany, April 28, 1920.)

Carbazol. — Carbazol is purified and obtained in well-defined crystals by slow dilution of its solution in concentrated sulphuric acid. This may be effected by exposing the solution to the atmosphere or other moist gas, with or without agitation, or by blowing air or other moist gas through the solution. The solution may first be diluted rapidly to a degree short of precipitation and then diluted slowly as described above. (Br. Pat. 139,441—1919. SOUTH METROPOLITAN GAS CO. and W. KIRBY, London, April 28, 1920.)

Treating Vegetable Fibers.—Vegetable fibers in the raw state, or bleached, or mercerized, and in the mass or in the state of laps, cops, card-ends, twistings, etc., or yarns or fabrics, are treated to impart to them the character of wool by steeping them at ordinary temperatures in nitric acid, preferably at a concentration of not less than 65 per cent, and then squeezing and washing the fibers. (Br. Pat. 136,568—1919, 136,569—1919. SOC. GILLET ET FILS, Lyons, France, Feb. 11, 1919.)

Current Events
in the Chemical and Metallurgical Industries

American Ceramic Society to Hold Summer Meeting at Chicago

The regular summer meeting of the American Ceramic Society will be held at the La Salle Hotel in Chicago Aug. 16, 17 and 18. Aside from a short business meeting the tentative program as outlined by the committee of the Chicago Section will be as follows:

MONDAY, AUG. 16

The members will assemble in the rooms provided at the La Salle Hotel about noon and will be taken by automobile to the plant of the Northwestern Terra Cotta Co. After an inspection of this plant the Lindsay Light Co.'s manufacturing plant will be visited. This company is engaged in the reduction of rare earths to be used in the manufacture of lamp mantles which the company produces, together with some of the rare metal compounds such as thorium, cerium, lanthanum and other nitrates derived from monazite sands.

TUESDAY, AUG. 17

Visit to the plant of the Coomley Manufacturing Co., maker of enamelware; the plant of the Burke Brick Co., manufacturer of common brick, and the Western Electric Co. plant.

WEDNESDAY, AUG. 18

A trip will be made to the manufacturing plants in the vicinity of Waukegan and North Chicago, including the Fansteel Products Co., manufacturer of pure tungsten, molybdenum and rare metals.

On Monday evening the informal dinner will be held at the La Salle Hotel, and on Tuesday and Wednesday evenings the visitors will be left to their own devices.

The detailed program will be published later.

Chemical Warfare Service on a Peace Basis

By July 1 the personnel of the Chemical Warfare Service will have been reduced by 50 per cent. This is by way of a general reduction from a war footing to a peace basis. The peace nucleus of the Chemical Warfare Service, however, expects to be a very active branch of the War Department. It has $4,000,000 at its disposition to use in its work during the next fiscal year. The manufacture of the latest type of the American gas mask is now reaching quantity production. The first mask of this type was completed June 4. Sufficient masks must be manufactured to equip the entire Army and National Guard. The new mask is described as a real fighting mask. It is comfortable to wear, permits clear vision and can be kept on continually, without particular inconvenience, as long as the wearer can go without food and drink.

Formal designation of the chief of the Chemical Warfare Service, who is to have the rank of Brigadier General, will take place shortly after July 1, it is believed, when the Chief of Staff will have returned from France. It is taken for granted that Colonel Amos A. Fries, who has been at the head of the service since the resignation of General Sibert, will be elevated again to the rank of general and assigned to the direction of the service in its permanent capacity as a separate branch of the War Department.

The Chemical Warfare Service, according to the new statute, is to have 100 officers. Only six of the officers now on duty with the Service hold permanent commissions, consequently ninety-four officers must be commissioned or detailed for duty with the Chemical Warfare Service. At present a large number of those interested in obtaining permanent commissions are taking the necessary examinations. It is the policy of Colonel Fries that 25 per cent of the officers be chemists. The principal duties of the remainder are of a military, constructional and manufacturing character, but even in those cases some chemical education is regarded as desirable.

In this connection, it may be remarked that the Chemical Warfare Service to date has been conducted almost entirely by temporary officers. They are responsible for much of the success which has been made by the Service. When the armistice was signed only 1 per cent of the officers in the Chemical Warfare Service were Regular Army men. Most of those were in the minor grades.

Resolutions Passed by the Natural Gas Conservation Conference

Definite progress was made in the Natural Gas Conservation Conference at the Department of the Interior on June 11, when tentative resolutions proposed by the National Committee on Natural Gas Conservation were approved. The conference included representatives of the Governors and Public Service Commissions of a number of the important natural gas producing and using states.

Some of the resolutions which were thus approved relate to industrial chemical activity very directly. Carbon black production, casinghead-gas recovery, and the substitution of natural gas for gas oil in making carburetted water gas are of special concern. The text of these resolutions is as follows:

> That the use of high B.t.u. natural gas instead of gas oil in carburetting manufactured gas, where same is made to supplement the decline in production of natural gas, be encouraged because the use of gas oil at 73c. per gal. has the equivalent B.t.u. value of 108 cu.ft. of natural gas at 1,100 B.t.u., giving the gas a comparative value of 75c. per 1,000 cu.ft. and thereby helping conservation.
>
> That carbon black be made when gas is produced in isolated sections with no present or reasonably prospective market for gas being produced, when gasoline has been extracted and when practical and modern and improved methods are used.
>
> That in the interests of good conservation and good service—wherever expedient—all gasoline that can be commercially separated from natural gas shall be so separated before the gas is started for market.
>
> That the Bureau of Mines be asked to turn over to this committee all data it may have on the carbon black industry with the view and purpose of helping this com-

mittee to determine what part of natural gas now used to manufacture carbon black could be diverted into public utility lines.

It is expected that a conference of state representatives of Pennsylvania, West Virginia and Ohio will meet soon in Pittsburgh to formulate a policy with respect to the gas exported from West Virginia into the two other states. It is hoped that similar measures mutually satisfactory to exporting and importing states will be arranged for Oklahoma, Kansas and Missouri, etc. It is also expected that regulations similar to the resolutions adopted by the conference will be made legally binding by some of the state legislatures. Especially is this action expected in Louisiana, where the Conservation Commissioner plans to introduce such legislation.

Federal Officials Organize

More than a hundred members of the Government service who are in responsible administrative and technical positions met on June 17 and perfected a tentative organization which is to be known as "The Federal Club." The purpose of the organization is by the interchange of views, and, where appropriate, by joint action to care for many of the general problems of the service which are common to several departments. Franklin D. Roosevelt, Assistant Secretary of the Navy, is the chairman of the temporary body, and Dr. E. B. Rosa, chief physicist of the Bureau of Standards, is chairman of the committee on organization and constitution. Some of the problems which have been suggested for the action of the club are classification and salaries of the technical services of the Government, and budget matters as affecting the executives of the various Bureaus.

New Zinc Oxide Company Formed at Leadville, Col.

The Western Zinc Oxide Co. has been recently formed at Leadville, Col., by a consolidation of the Western Zinc Concentrating Co. and the Leadville Zinc Co. The new company is controlled by J. F. McDonald, of Leadville, Charles J. Walker, of St. Louis, and other St. Louis capitalists. They are connected with the Downtown Mines Co.

A block of sixteen furnaces, a new pipe line, bag house and complete mining equipment is being added to the present plant. When the new unit is completed thirty-four furnaces will be in daily operation, giving the plant a capacity of about 100 tons of zinc oxide daily.

The new furnace building will be 120 ft. long by 44 ft. wide, and the bag house 700 ft. by 44 ft. Wetherill type furnaces are being built. It is planned to have the new unit in operation by Aug. 1. Charles H. Collins is president and manager of the new company.

Allocation of German Dyes

The War Trade Board Section of the Department of State announces that it is now prepared to grant allocation certificates providing for the importation of German dyes in amounts sufficient to supply the immediate requirements of individual consumers of the United States for a six months' period.

Before an allocation certificate providing for the issuance of an import license will be granted by the War Trade Board Section the consumer must file an application with the War Trade Board Section on an official form provided for that purpose.

Applicants are advised to estimate their requirements as accurately as possible, as all estimates will be carefully scrutinized. Any applications which appear to be excessive will not be acted upon until the matter has been investigated and found satisfactory to the War Trade Board Section.

Importations will be controlled by rules and regulations similar to those which governed the previous allocations. Licenses to import will be issued only when the dyes applied for are not obtainable from domestic sources on reasonable terms as to price, quality and delivery.

New Bodies Represented on the American Engineering Standards Committee

Five additional bodies have been admitted to representation on the main committee of the American Engineering Standards Committee. They are:

Electrical Manufacturers Council: Electric Power Club, Associated Manufacturers of Electrical Supplies, Electrical Manufacturers Club.

Fire Protection Group: National Fire Protection Association, National Board of Fire Underwriters, Associated Factory Mutual Fire Insurance Companies, Underwriters Laboratories.

National Electric Light Association.

National Safety Council.

Society of Automotive Engineers.

These, with the five engineering societies who founded the Committee and the three Government departments, added later (Commerce, Navy and War), make a total of thirteen organizations having representation on the main committee.

The constitution of the A.E.S.C. provides for representation of "groups of organizations." It is the policy of the committee to encourage representation by groups in such manner that a group shall represent substantially the entire field of a particular industry in order that it may "be of national scope." In the opinion of the committee the group plan makes both for efficiency in standardization work and for effectiveness of representation. The groups are autonomous, such matters as the apportionment of representatives and the allotment of fees among the constituent bodies resting wholly with the group.

Two of the new bodies have already designated their representatives as follows:

Electrical Manufacturers Council: Le Roy Clark, A. H. Moore, C. E. Skinner.

National Safety Council: C. P. Tolman, chairman, Manufacturing Committee; Albert W. Whitney, general manager, National Workmen's Compensation Service Bureau; Sidney J. Williams, secretary and chief engineer.

Storage of Poisonous Gases

Poisonous gases store very much better than had been expected. Recently completed tests by the Chemical Warfare Service show that all gases used in warfare except mustard and sulphur monochloride can be stored for long periods without deterioration. Even in the case of mustard gas, the deterioration is not great. All of the gases which were the subject of these tests had been in storage at least twenty months. Due to the corrosive properties of chlorine, some difficulty has been found in preventing its escape from containers after long periods of storing.

Uses of Bentonite Clay

Bontonite clay is a non-metallic mineral of commercial importance used in the manufacture of soap and antiphlogistine and the purification of water. It is produced principally in Wyoming and is marketed to the extent of a few hundred tons per year. Detailed information can be found in the United States Geological Survey Bulletins Nos. 260, 285 and 365; also in U. S. Geological Survey Professional Paper No. 153.

Mantle Lights Used in Canton

Many concerns in Canton use mantle lights, often burning gasoline or a low grade of kerosene. Those now on the market sell at from 30c. to 65c. each and come principally from the United States and England.

Personal

Prof. S. A. ARRHENIUS of Nobel Institute, Stockholm, Sweden, was awarded the Frank Medal by the Franklin Institute, May 19, 1920. Dr. Allerton S. Cushman, in connection with the presentation, read a paper by Prof. Arrhenius entitled "The World's Energy Supply."

Dr. JAMES BROWN, formerly research chemist for Zinsser & Co., Hastings-on-Hudson, N. Y., has accepted a similar position with the Calco Chemical Co., Bound Brook, N. J.

GEORGE A. CHRITTON spoke before the Chicago Chemists' Club weekly luncheon on trade marks, unfair trade and the law.

H. P. FISHBURN, formerly with the University of Idaho, is now chief chemist at the Casper, Wyo., works of the Standard Oil Co. of Indiana.

Dr. LOUIS J. GILLESPIE, professor of physical chemistry at Syracuse University, who was formerly with the Department of Agriculture, Washington, D. C., has resigned to go to the Massachusetts Institute of Technology as assistant professor on physicochemical research in the research laboratories of physical chemistry.

HOWARD A. HORNER, formerly metallurgist of the American Metallurgical Corporation, Philadelphia, is now with the Frick Co. of Waynesboro, Pa.

ROBERT M. KEENEY of Denver was East recently on a business trip.

FRANKLIN K. LANE, formerly Secretary of the Interior, received the honorary degree of Doctor of Laws at the commencement exercises at Williams College June 21.

OLIVER LOUD, formerly plant chemist of the citrus by-product factory of the California Fruit Growers Exchange, Corona, Cal., and during the war assistant in physiological research with the Chemical Warfare Service, is now engaged as chemist at the refinery of the Standard Oil Co. of California, Richmond, Cal.

A. M. MUCKENFUS has resigned as professor of organic and industrial chemistry and director of that sub-department at Emory University, Atlanta, Ga., to accept the position of research chemist with the Roessler & Hasslacher Chemical Co., Perth Amboy, N. J.

Sir W. J. POPE is to be nominated president of the Society of Chemical Industry, London, at the meeting to be held at Armstrong College, Newcastle-on-Tyne, July 13, 1920.

PAUL C. SKINNER, general manager of the Denver plant of the General Chemical Co., has been in Chicago recently on business.

HARRY A. TIEMANN, Colorado State Superintendent of Industrial Education, delivered an address recently before the Colorado Society of Engineers.

Current Market Reports

The Non-Ferrous Metal Market

New York, June 28, 1920.—The leading producers quote 19c. for all copper deliveries up to August, with the outside market at 18c. for spot. Platinum and palladium have advanced $5. Other prices are firm.

	Cents per Lb.
Copper, electrolytic	18.00@19.00
Aluminum, 98 to 99 per cent.	33.00
Antimony, wholesale lots	8.00
Nickel, ordinary	45.00
Nickel, electrolytic	45.00
Tin, Straits, spot	48.50
Lead, New York, spot	8.00
Lead, E. St. Louis, spot	7.75
Zinc, spot, New York	7.75
Zinc, spot, E. St. Louis	7.45

OTHER METALS

Silver (June 24)	oz.	$0.99½
Cadmium	lb.	1.40@1.50
Bismuth, (500 lb. lots)	lb.	2.70@3.00
Cobalt	lb.	2.50@3.00
Magnesium (f.o.b. Niagara Falls)	lb.	1.60@1.85
Platinum	oz.	80@90
Iridium	oz.	300
Palladium	oz.	75@85
Mercury	75 lb.	90

FINISHED METAL PRODUCTS	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	33.50
Copper bottoms	38.00
Copper rods	38.00@40.00
High brass wire and sheets	30.25
High brass rods	25.00
Low brass wire and sheets	28.50
Low brass rods	29.00
Brazed brass tubing	43.25
Brazed bronze tubing	41.75
Seamless copper tubing	34.00
Seamless high brass tubing	33.00

SCRAP METALS	Cents per Lb. Buying Price
Aluminum, cast scrap	24.00@24.50
Aluminum, sheet scrap	24.00@24.50
Copper, heavy machinery comp	15.00@15.50
Copper, heavy and wire	14.25@14.75
Copper, light and bottoms	12.50@13.00
Copper, heavy cut and crucible	15.00@15.50
Brass, heavy	9.00@10.00
Brass, light	7.50@ 8.00
No. 1 clean brass turnings	9.25@ 9.75
No. 1 comp. turnings	13.00@13.50
Lead, tea	5.00@ 5.50
Lead, heavy	7.00@ 7.25
Zinc, scrap	5.00@ 5.25

The Iron and Steel Market

Pittsburgh, June 25, 1920.

The rail transportation situation is growing no better, and even the more sanguine in the iron and steel industry do not look for any decided improvement until some distinctly new developments occur. Announcement of the findings of the Railroad Labor Board, expected now in two or three weeks, might help.

While there is no noticeable improvement in the shipment of pig iron or of finished steel, there is a distinct improvement in the movement of coal, at least from the Pittsburgh district, this arising without doubt from the coal car preference order of the Interstate Commerce Commission, effective at the beginning of last week. Connellsville coke operators complain that the order will result in the withdrawal of cars from the coke movement to put into the coal movement, but any such change if made would probably be to the advantage of the iron industry as a whole, through there being a better movement of coal to byproduct coke ovens.

Production of pig iron and steel ingots is at about the same rate as a week or a fortnight ago, the rate being not far from that of last March, when the highest rate was attained since October, 1918. In view of rather light demand in some quarters it is doubtful whether the total of demand is equal to the present rate of production. There is very little railroad demand and there is no large amount of steel being required for large works of construction. The Bridge Builders' and Structural Society reported May book-

ings of fabricated steel contracts equal to 61½ per cent of a month's capacity, against 68 per cent for April and 83½ per cent for March. Not a few manufacturing consumers are operating at well under capacity, partly from lack of orders, and even the automobile industry has slowed down, though that is of less consequence than would be assumed from the large part the automobile industry played in advancing the market early in the year, since at best the industry could not fill up more than say 6 or 7 per cent of the steel industry's capacity. An easier market for steel in the not distant future is therefore in prospect, unless there should be a large curtailment in output by labor disturbances or from fear of labor disturbances.

Market Prices

Connellsville coke continues very strong, with prices for spot shipment up 50c. to $1 in the week, furnace coke being $15.50@$16 and foundry coke $16@$17 per net ton at ovens. Some operators are quoting $12 as a flat price for furnace coke for second half, a price furnaces are unwilling to pay. There are also quotations at a ratio of 4 to 1 against basic pig iron at valley furnaces, which at the present pig iron market of $44 would mean $11 for the coke. Some coke operators expect pig iron to advance, while furnacemen who have bought on the 4 to 1 ratio probably expect it to decline.

A sale of 2,000 tons of bessemer pig iron at $44, valley, establishes the minimum of the market at this figure, an advance of $1, while small lots have gone at $45. Basic sold in one 2,000-ton lot at least at $44, an advance of 50c. Foundry remains at $45, valley. The market is made only by early deliveries, there being no disposition on the part of consumers to buy for the remainder of the year, and thus the technical position is one that readily admits of advances or declines in future. The present market, being made on prompt lots at a time when deliveries are difficult, is not much of a criterion.

A sale of over 5,000 tons of open-hearth sheet bars has been made at $75, which would indicate a continuance of the very strong market, but there were attendant circumstances suggesting that the buyer had some ulterior motives in making the purchase. A sale of a fair tonnage of 3 x 3-in. billets is reported at $67.50, indicating an easier market, since standard billets have been quotable nominally at $60@$65 and small billets not long ago were regarded as worth $10 over 4 x 4-in. billets.

The plate market is easier, as prompt deliveries will hardly bring 3.50c., perhaps not over 3.25c., while not long ago very late deliveries were in demand at 3.25c. and prompt deliveries were bringing up to 4.50c. Other descriptions of finished steel have softened less, but the general trend is for prompt deliveries to bring smaller premiums than formerly, with extended deliveries held at former levels, but in less demand.

A few lots of heavy melting steel have been bought by Pittsburgh district consumers in the past week at $26.50, delivered. Nominally these transactions record an advance of 50c. in the market, but it is characteristic of the scrap market to have a certain level as "the market" and then when consumers buy they pay 50c. more. Borings have been in good demand at $18, with $18.50 now quoted, while machine shop turnings are off $1, at $14.50@$15. Cast scrap is stronger at $33@$34 and cupola sizes are stronger at $40@$41, both cases reflecting the difficulty in securing pig-iron deliveries.

Ferro-Alloys

Prompt ferromanganese has slumped, as was to be expected, the recent stiffness being due to a few consumers being short at the time, although covered for second half, and prompt is now worth but little more than the $200, delivered, which is still quoted on second half contracts. Spiegeleisen is $72.50@$75 at furnace. Electrolytic ferrosilicon is about $78@$80, delivered, for 50 per cent and $150, delivered, for 75 per cent. Bessemer ferrosilicon remains quotable at $62.50 for 10 per cent, $65.80 for 11 per cent and $69.10 for 12 per cent, f.o.b. furnaces at Jackson and New Straitsville, Ohio.

The Chemical and Allied Industrial Markets

New York, June 25, 1920.

The chemical market continues in the same weak position it occupied during the previous period, buying being confined to present requirements only and offerings being small with no assurance of early delivery. It is difficult to decide whether there has been any improvement in the rail situation with so many conflicting opinions being given by those engaged in the trade, but it is evident that there are more cars rolling and that terminal facilities are less congested than they were a few weeks ago. Succeeding *barium chloride*, which is still nominally quoted at $170@$200 per ton, *copperas* has come up in the last week or two and is commanding prices ranging between $3 and $4 per cwt. There is considerable difficulty in locating spot even at these figures and the best that producers can offer is late summer shipment. Domestic producers are standing firm at 12½@13½c. per lb. for *gray salammoniac* and 16@16½c. for the *white* grade. While it is reported English material is being imported a few cents below this price, volume of imported arrivals has not yet reached proportions that have warranted a reduction in domestic material. Improvement has been noticed in the *muriatic* supply and this material is accordingly somewhat easier at $3.10@$3.25 per cwt., although there is by no means a normal supply on hand, which is partly due to the slow arrival of material from producers' plants.

Considerable interest is being manifested in *carbon tetrachloride* and buying has been active at 12@15c. per lb. depending on the quantity and time of shipment desired. *Salt cake* has come up another notch and it is practically impossible to locate material at less than $30 per ton, and $34 seems to be the average price being asked by those holding resale material. There is some *caustic soda* offered at $6@$6.25 per cwt., but how much is obtainable at this figure it would be hard to say. It is rumored, however, that the firm making this offer has considerable supplies on hand. *Glycerine* continues at former levels, with 28c. the average price, and *sodium bicarbonate*, which is practically out of the hands of producers, who are sold out, came up to $2.45 as a low mark, against $2.25 per cwt. of the previous report.

Coal-Tar Products

The best that can be said about this market is that it is no worse than it was last week, implying no changes of real importance. The unsettled conditions which still prevail in Japan are a contributing factor to the continued dullness evident in this market. Buying is light, but offerings of the more desirable items on the list are lighter, and the trade continues to jog along with a noticeable mark of expectancy in its stride. *Naphthalene* is still off the market with resale material being offered nominally at 18c. per lb.; one large producer of this item is still making deliveries on contracts at 9c., which is in turn being offered on the open market at prevailing figures. There has been little interest displayed in *aniline* oil, which is listed around 35c. per lb., while, on the contrary, *aniline* salts have come up slightly with a low mark of 42c. per lb.

Oils

There has been no activity evidenced in this market during the period. The Japanese situation is tending to keep the market for Oriental oils quiet and while no drops of importance have occurred the only reason is that there is no material being offered and no inquiry being made. *Chinawood* oil, which has been steadily declining, is down as low as 18½@19½c. per lb., with practically no business being done. *Cottonseed* also came down and crude is offered as low as 15½c. per lb. *Summer yellow* is being bid around 18¾@19c. per lb.

St. Louis, June 21, 1920.

The demand for heavy chemicals, which has been manifested for the past few months, still continues and prices in some lines show an upward trend. Local production is practically back to normal, although producers are hampered by the slow movement of carload shipments. A recent local embargo on less than carload shipments, caused by a strike of the transfer companies' employees, has held up all

shipments to and from the East. This strike is now settled and the embargo should be lifted shortly.

Sulphuric Acid—The demand for sulphuric acid continues good and prices are unchanged. The 60 deg. grade is quoted at $15@$16 per ton in carload lots and the 66 deg. grade at $22 per ton. The price of oleum is unchanged at $27.50 per ton.

Muriatic Acid—The demand for this chemical is heavy and local producers report supply practically all sold up. The 18 deg. is quoted in carload lots at $25 per ton and $2 to $2.25 per 100 lb. in carboys. This is an advance of $4 per ton in the past two weeks.

Nitric Acid—Supply plentiful and prices unchanged. Quoted in carload lots at $7 per cwt. for 36 deg. grade, $8 for 38 deg., $9 for 40 deg. and $10 for 42 deg.

Sodium-Bisulphate—Demand is heavy and the supply limited. Quoted at $6 per ton. This is an advance of $2 per ton during the past two weeks.

Phenol—The supply of this chemical is plentiful and demand continues good. Quotation unchanged at 12c. per lb. in quantities of 15 tons or over.

Zinc Chloride—Price unchanged at $3.50 to $3.75 per cwt.

Zinc Oxide—Local supplies are very low and producers quoting 10c. per lb., in large lots, for third quarter delivery.

Chicago, June 23, 1920.

The very gradual return to normal trade conditions in the chemical market continues, although it is so gradual as to cause the general appearance to remain almost the same from week to week. Such price changes as have been noted have, with a few exceptions, been downward and the whole trade seems to be quietly and calmly awaiting developments.

As a unit, freight conditions are improved. Plenty of individuals can be found who will assert the contrary, but these are interests whose sources of supply happen to be in points still embargoed, or whose rolling stock requirement is such that they have particular difficulty in securing cars.

Heavy Chemicals

Alcohol and its derivatives remain the headliners so far as demand is concerned. Today's quotation on methyl grade, 95 per cent, is $3.65 per gal. in barrels, when obtainable. Dye, celluloid and similar manufacturers whose requirements for wood alcohol is absolute are being supplied after a fashion, but all consumers who can possibly use *denatured* are being forced to the slower acting product. This is in fair supply and can be had at $1.09@$1.11 per gal. *Ethyl* grade is in better supply than for some time in the past and is quoted in single barrels at $5.57½ per gal. and 5c. less in 5-bbl. lots. The alcohol condition is subject to steady improvement, as factories handicapped by their inability to secure adequate supplies of molasses are being converted to corn.

Formaldehyde is in about the same condition it has occupied for the past two months so far as supply is concerned, but apathetic buying has forced the price down to 53c. per lb. in barrels. Trade needs greatly exceed visible supply, but this is a condition which, with the opening of several new producing plants, will be gradually overcome. There is apparently nothing to prevent lower prices on this commodity in the near future. The previously noted strong tone to *glycerine* continues, present quotation on c.p. grade being 28c. per lb. in drums. Manufacturers report less transportation trouble recently but shipments are still uncertain.

In general, *alkali* products are off fractionally. The main trouble is in the difficulty of shipping goods from the factory, producers reporting variously a car shortage of from 40 per cent to 90 per cent of their requirement. The trade, knowing that local supply is bound to be easier some time, and probably soon, are reluctant to pay high prices. Today *soda ash* is quoted on contract at 3½c. per lb. and for immediate delivery out of stock at 3¾c. These figures represent a quarter cent decline. *Caustic soda*, at 6@6½c. per lb., is also off ¼c. *Sal soda* remains unchanged at $1.60@$1.65 per cwt., the concentrated being offered at $3 per cwt. *Bleaching powder* is up sharply, 7c. per lb. being asked for delivery from stock and but little to be had at any price.

Blue vitriol has been subject to frequent fluctuation with a range of only about ¾c. Today's quotation on the large crystals in carloads is 8¼c. *Aqua ammonia*, on contracts, remains unchanged, and spots have been unable to retain their previous high mark, being quoted now at 9½@10c. Short supply has forced spot quotation on *copperas* up to 4c. per lb. and producers are not able to supply the demand. *Soda nitrite* is sharply off, offers being made in the neighborhood of 20c. per lb. Available stocks are being reduced and further fluctuation is to be expected. Some interest has been shown in *carbon tetrachloride*, with spots occasionally offered below the factory price. Quotations have ranged all the way from 11@12¾c. per lb. and the market remains uncertain. *Salt cake* is up, spots bringing $40 a ton and even more.

Coal-Tar Products

The word dull describes the coal-tar market in all its factors. Because the demand for *benzol* is more pressing than for other items of the line its shortage is most obvious. Difficulty in shipping the goods is the principal obstacle, and this is not so pronounced as in the recent past. Today's receipts are offered at 28c. per gal. in cars. *Toluol* is almost as scarce and is likewise held at 28c. *Cresol* has shown an upward tendency, recent offerings being around 17c., but demand is showing a decided falling off.

Aniline oil and *aniline salt* have reacted from their high marks of May and are now offered at 33@35c. and 37@40c. per lb. respectively. Supplies remain very short, but users seem unwilling to pay the price in the face of increasing volume of supply coming from the producer. Former quotations on *naphthaline* of 16c. per lb. on balls and 15c. on flakes hold good. Supply is limited in the face of an active demand. Coal-tar acids remain practically unchanged in price with the exception of *picric* which is up to 29@30c. per lb., and has become hard to locate even at that figure, and *salicylic* which has been offered as low as 48c. The entire coal-tar line is subject to frequent fluctuation which denies a healthy tone to the market.

Vegetable Oils

The oils, for some time the weakest of the chemical lines, show further reductions and increased lack of interest. *Linseed oil* alone is practically holding its own, $2.02 per gal. being the current quotation on the raw product in barrels out of local stocks, and $1.65@$1.70 ruling on carload lots. Varying guesses on the incoming crop of flax seed have a tendency to discourage active buying and a drop in price is freely predicted in some quarters.

Oriental oils, already weakened by the Japanese financial crisis, were further affected by the recent failure of a large brokerage concern on the Coast. It is rumored that this will precipitate large stocks of various oils on the market for immediate sale. Consumers are inclined to be cautious in buying for the added reason that, in many cases, they are unable to effect shipment of their finished products. This combination of circumstances has forced prices down to a new level. *Manila coconut oil* is quoted in sellers' tanks on the Coast at 16¼@16¾c. per lb., the same grade going for 16@16¼c. in barrels f.o.b. Chicago. Actual transactions are few and some were at an even lower figure. *Soya bean oil* in tanks, f.o.b. Coast, is 12@12½c., with the refined, deodorized grade bringing 16@16½c. from local stocks in barrels.

Nominal quotation on *corn oil*, prime, in tanks, is 14¾@15c., with practically none changing hands. *Cottonseed oil* is equally quiet, car quotations being, on crude around 14c. and on prime summer yellow, 17c. Cash offers would probably entice lower figures.

Flotation Oils—Naval Stores

Present quotations must be regarded as purely nominal, premiums being the rule rather than the exception. *Turpentine*, pure gum spirits, is quoted at $2.18@$2.25 per gal. *Pine oil*, equally scarce and desirable, is $2 for the .933 pure steam-distilled and $1.85@$1.90 for the destructively distilled. Approximately similar conditions prevail in *rosins*, with local market ranging from $3 to $4 above Savannah on the various grades.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	.....	$0.65 – $0.75
Acetone	lb.	$0.15 – $0.20	.21 – .22
Acid, acetic, 28 per cent	cwt.	3.50 – 3.75	4.00 – 4.50
Acetic, 56 per cent	cwt.	6.00 – 7.50	8.00 – 9.00
Acetic, glacial, 99½ per cent, carboys	cwt.	15.50 – 16.00	16.50 – 17.50
Boric, crystals	lb.	.15 – .15½	.15½ – .16½
Boric, powder	lb.	.15 – .15½	.15 – .16
Citric	lb.	1.05 – 1.12	1.17 – 1.18
Hydrochloric (nominal)	cwt.	2.00 – 3.00	3.10 – 3.25
Hydrofluoric, 52 per cent	lb.	.13½ – .14	.14½ – .15½
Lactic, 44 per cent tech	lb.	.11 – .11½	.12 – .16
Lactic, 22 per cent tech	lb.	.04½ – .05½	.06 – .07
Molybdic, C. P.	lb.	4.00 – 4.50	4.50 – 5.00
Muriatic, 20 deg. (see hydrochloric)		.....	.....
Nitric, 40 deg.	lb.	.06 – .07	.07½ – .08½
Nitric, 42 deg.	lb.	.07½ – .08	.08½ – .09½
Oxalic, crystals	lb.	.55 – .57	.60 – .65
Phosphoric, Ortho, 50 per cent solution	lb.	.14 – .23	.24 – .25
Picric	lb.	.28 – .35	.40 – .50
Pyrogallic, resublimed	lb.	2.25 – 2.55	2.60 – 2.65
Sulphuric, 60 deg., tank cars	ton	14.00 – 19.00	.....
Sulphuric, 60 deg., drums	ton	.....	.....
Sulphuric, 66 deg., tank cars	ton	23.00 – 24.00	25.00 – 26.00
Sulphuric, 66 deg., drums	ton	35.00 – 40.00	45.00 – 50.00
Sulphuric, 66 deg., carboys	ton	36.00 – 40.00	50.00 – 55.00
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	27.00 – 30.00	37.00 – 42.00
Sulphuric, fuming, 20 per cent (oleum) drums	ton	28.00 – 30.00	38.00 – 42.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	32.00 – 35.00	40.00 – .....
Tannic, U. S. P.	lb.	1.45 – 1.50	1.55 – 1.60
Tannic (tech.)	lb.	.....	.60 – .90
Tartaric, crystals	lb.	.....	.80 – .85
Tungstic, per lb. of WO	lb.	.....	1.20 – 1.40
Alcohol, Ethyl (nominal)	gal.	5.10 – 5.50	6.00 – 7.00
Alcohol, Methyl, 95%	gal.	.....	2.50 – 2.70
Alcohol, Methyl, pure	gal.	.....	3.50 – 3.55
Alcohol, denatured, 188 proof (nominal)	gal.	.....	1.10 – 1.15
Alcohol, denatured, 190 proof (nominal)	gal.	.....	1.05 – 1.10
Alum, ammonia lump	lb.	.04½ – .05	.05½ – .06
Alum, potash lump	lb.	.07½ – .08½	.09 – .09½
Alum, chrome lump	lb.	.15½ – .18	.19 – .20
Aluminum sulphate, commercial (nominal)	lb.	.02 – .03	.03½ – .04½
Aluminum sulphate, iron free	lb.	.03½ – .04	.04½ – .04½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07½ – .10¾	.11 – .12
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	.32 – .35	.35 – .40
Ammonium carbonate, powder	lb.	.16 – .16½	.17 – .17½
Ammonium chloride, granular (white salammoniac) (nominal)	lb.	.16 – .16½	.17 – .18
Ammonium chloride, granular (gray salammoniac)	lb.	.12½ – .13½	.13½ – .14½
Ammonium nitrate	lb.	.08½ – .09½	.10 – .11
Ammonium sulphate	lb.	.07 – .07½	.08½ – .....
Amylacetate	gal.	.....	5.00 – .....
Amylacetate tech	gal.	.....	4.75 – 5.25
Arsenic, oxide, lumps (white arsenic)	lb.	.15½ – .16	.16½ – .17
Arsenic, sulphide, powdered (red arsenic)	lb.	.20 – .21	.22 – .23
Barium chloride	ton	150.00 – 160.00	170.00 – 200.00
Barium dioxide (peroxide)	lb.	.21 – .23	.24 – .25
Barium nitrate	lb.	.09½ – .11	.11 – .12
Barium sulphate (precip.) (blanc fixe)	lb.	.04½ – .05	.05½ – .06
Bleaching powder (see calcium hypochlorite)		.....	.....
Blue vitriol (see copper sulphate)		.....	.....
Borax (see sodium borate)		.....	.....
Brimstone (see sulphur, roll)		.....	.....
Bromine	lb.	.70 – .90	1.00 – 1.05
Calcium acetate	cwt.	3.50 – 3.55	.....
Calcium carbide	lb.	.04½ – .04½	.04½ – .05½
Calcium chloride, fused, lump	ton	23.00 – 25.00	30.00 – 40.00
Calcium chloride, granulated	lb.	.01½ – .01¾	.02 – .02½
Calcium hypochlorite (bleaching powder)	cwt.	4.00 – 4.25	4.50 – 6.50
Calcium peroxide	lb.	.....	1.50 – 1.70
Calcium phosphate, monobasic	lb.	.....	.75 – .80
Calcium sulphate, pure	lb.	.....	.25 – .30
Carbon bisulphide	lb.	.08 – .09	.10 – .11
Carbon tetrachloride, drums	lb.	.12 – .13	.13½ – .15
Carbonyl chloride (phosgene)	lb.	.....	.80 – 1.05
Caustic potash (see potassium hydroxide)		.....	.....
Caustic soda (see sodium hydroxide)		.....	.....
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.09 – .09½	.10 – .10½
Chloroform	lb.	.30 – .35	.36 – .38
Cobalt oxide	lb.	.....	2.00 – 2.05
Copperas (see iron sulphate)		.....	.....
Copper carbonate, green precipitate	lb.	.27 – .28	.29 – .31
Copper cyanide	lb.	.....	.65 – .70
Copper sulphate, crystals	lb.	.08 – .09	.09 – .09½
Cream of tartar (see potassium bitartrate)		.....	.....
Epsom salt (see magnesium sulphate)		.....	.....
Ethyl Acetate Com. 85%	gal.	1.35 –	1.40 – .....
Ethy Acetate pure (acetic ether 98% to 100%)		.....	1.75 – .....
Formald-hyde, 40 per cent (nominal)	lb.	.36 – .40	.57 – .65
Fusel oil, ref.	gal.	.....	5.25 – 6.00
Fusel oil, crude (nominal)	gal.	.....	.....
Glauber's salt (see sodium sulphate)		.....	.....
Glycerine	lb.	.....	.26½ – .28½
Iodine, resublimed	lb.	4.30 – 4.35	4.40 – 4.45
Iron oxide, red	lb.	.....	.03 – .20
Iron sulphate (copperas)	cwt.	.....	2.90 – 3.10
Lead acetate, normal	lb.	.....	.13½ – .16
Lead arsenate (paste)	lb.	.11 – .12	.13 – .17
Lead nitrate, crystals	lb.	.....	.90 – 1.00
Litharge	lb.	.14 – .15	.15½ – .16
Lithium carbonate	lb.	.....	1.50 – .....
Magnesium carbonate, technical	lb.	.12 – .14	.15 – .16
Magnesium sulphate, U. S. P.	100 lb.	3.00 – 3.55	4.00 – 4.50
Magnesium sulphate, commercial	100 lb.	.....	3.25 – 3.60
Nickel salt, double	lb.	.....	.14 – .16
Nickel salt, single	lb.	.....	.16 – .18
Phosgene (see carbonyl chloride)		.....	.....
Phosphorus, red	lb.	.50 – .55	.60 – .65
Phosphorus, yellow	lb.	.....	.35 – .37
Potassium bichromate	lb.	.35 – .37	.45 – .46
Potassium bitartrate (cream of Tartar)	lb.	.52 – .56	.57 – .58
Potassium bromide, granular	lb.	.80 – .85	.90 – .95
Potassium carbonate, U. S. P.	lb.	.....	.85 – .88
Potassium carbonate, crude	lb.	.21 – .25	.26 – .28
Potassium chlorate, crystals	lb.	$0.15 – $0.16	$0.21 – .....
Potassium hydroxide (caustic potash)	lb.	.28 – .29	.31 – .35
Potassium iodide	lb.	.....	3.35 – 3.60
Potassium nitrate	lb.	.15 – .17	.19 – .21
Potassium permanganate	lb.	.75 – .80	.85 – .95
Potassium prussiate, red	lb.	.90 – 1.00	1.05 – .....
Potassium prussiate, yellow	lb.	.32 – .36	.35 – .36
Potassium sulphate (powdered)	ton	$225.00 – 240.00	.....
Rochelle salts (see sodium potas. tartrate)		.....	.....
Salammoniac (see ammonium chloride)		.....	.....
Sal soda (see sodium carbonate)		.....	.....
Salt cake	ton	30.00 – 32.00	34.00 – 36.00
Silver cyanide (nominal)	oz.	.....	1.25 – .....
Silver nitrate (nominal)	oz.	.....	.74 – .76
Soda ash, light	100 lb.	.....	3.50 – 3.60
Soda ash, dense	100 lb.	.....	3.55 – 3.65
Sodium acetate	lb.	.08½ – .09	.09½ – .12
Sodium bicarbonate	100 lb.	2.45 – 2.60	2.75 – 3.50
Sodium bichromate	lb.	.30 – .33	.34 – .36
Sodium bisulphate (nitre cake)	ton	7.00 – 7.50	8.00 – 10.00
Sodium bisulphite Powered	lb.	.06 – .06½	.07 – .10½
Sodium borate (borax)	lb.	.09 – .10	.11 – .12
Sodium carbonate (sal soda)	100 lb.	1.60 – 1.80	1.80 – 2.00
Sodium chlorate	lb.	.10 – .10½	.10½ – .11
Sodium cyanide, 96-98 per cent	lb.	.24 – .25	.26 – .27
Sodium fluoride	lb.	.18 –	.19 – .20
Sodium hydroxide (caustic soda)	100 lb.	4.25 – 6.00	6.25 – 6.50
Sodium hyposulphite	lb.	.....	.03 – .04
Sodium molybdate	lb.	2.50 –	3.25½ – .....
Sodium nitrate	100 lb.	3.00 – 3.25	3.75 – 4.00
Sodium nitrite	lb.	.19 – .19½	.20 – .21
Sodium peroxide, powdered	lb.	.32 – .35	.35 – .40
Sodium phosphate, dibasic	lb.	.03½ – .04½	.04½ – .05
Sodium potassium tartrate (Rochelle salts)	lb.	.....	.39 – .40
Sodium prussiate, yellow	lb.	.23 – .27	.31 – .32
Sodium silicate, solution (40 deg.)	lb.	.01½ – .01½	.02 – .02½
Sodium silicate, solution (60 deg.)	lb.	.02½ – .03	.04 – .05
Sodium sulphate, crystals (Glauber's salt)	cwt.	1.60 – 1.70	1.75 – 2.50
Sodium sulphide, crystal, 60-62 per cent (conc)	lb.	.09 – .10	.10½ – .11
Sodium sulphite, crystals	lb.	.03½ –	.04 – .06
Strontium nitrate, powdered	lb.	.17½ – .18½	.19 – .20
Sulphur chloride	lb.	.05½ –	.06 – .....
Sulphur, crude	ton	22.00 –	.....
Sulphur dioxide, liquid, cylinders	lb.	.09 –	.10 – .12
Sulphur (sublimed), flour	100 lb.	3.35 –	3.40 – 3.65
Sulphur, roll (brimstone)	100 lb.	3.20 –	3.30 – 3.40
Tin bichloride (stannous)	lb.	.42½ –	.46 – .50
Tin oxide	lb.	.60 – .63	.65 – .....
Zinc carbonate, precipitate	lb.	.16 – .18	.19 – .20
Zinc chloride, gran.	lb.	.13 – .13½	.13½ – .17
Zinc cyanide	lb.	.49 –	.50 – .60
Zinc dust	lb.	.12½ –	.13 – .15
Zinc oxide, U. S. P.	lb.	.18 – .19	.20 – .21
Zinc sulphate	lb.	.03½ – .03¾	.04 – .06

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude	lb.	$1.40 —	$1.50
Alpha naphthol, refined	lb.	1.60 —	1.70
Alpha naphthylamine	lb.	.55 —	.60
Aniline oil, drums extra	lb.	.35 —	.40
Aniline salts	lb.	.42 —	.50
Anthracine, 80% in drums (100 lb.)	lb.	.90 —	1.00
Benzaldehyde (f.f.e.)	lb.	2.00 —	2.10
Benzidine, base	lb.	1.35 —	1.40
Benzidine, sulphate	lb.	1.15 —	1.25
Benzoic acid, U.S.P.	lb.	.90 —	1.00
Benzoate of soda, U.S.P.	lb.	.80 —	.90
Benzol, pure, water-white, in drums (100 lb.)	gal.	.27 —	.40
Benzol, 90%, in drums (100 lb.)	gal.	.25 —	.31
Benzyl chloride, 95-97%, refined	lb.	.35 —	.40
Benzyl chloride, tech.	lb.	.25 —	.35
Beta naphthol benzoate (nominal)	lb.	3.50 —	4.00
Beta naphthol, sublimed (nominal)	lb.	.80 —	.90
Beta naphthol, tech (nominal)	lb.	.65 —	.85
Beta naphthylamine, sublimed	lb.	2.25 —	2.40
Cresol, U. S. P., in drums (100 lb.)	lb.	.18 —	.19
Ortho-cresol, in drums (100 lb.)	lb.	.23 —	.25
Cresylic acid, 97-99%, straw color, in drums	gal.	1.10 —	1.20
Cresylic acid, 95-97%, dark, in drums	gal.	1.00 —	1.05
Cresylic acid, 50%, first quality, drums	gal.	.65 —	.75
Dichlorbenzol	lb.	.08 —	.10
Diethylaniline	lb.	1.50 —	1.60
Dimethylaniline	lb.	1.35 —	1.55
Dinitrobenzol	lb.	.30 —	.37
Dinitroclorbenzol	lb.	.30 —	.35
Dinitronaphthaline	lb.	.45 —	.55
Dinitrophenol	lb.	.40 —	.45
Dinitrotoluol	lb.	.40 —	.45
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38 —	.40
Diphenylamine (nominal)	lb.	.80 —	.85
H-acid (nominal)	lb.	2.25 —	2.50
Metaphenylenediamine	lb.	1.15 —	1.30
Monochlorbenzol	lb.	.18 —	.20
Monoethylaniline	lb.	2.00 —	2.40
Naphthaline crushed, in bbls. (250 lb.)	lb.	.17 —	.....
Naphthaline, flake	lb.	.17 —	.18
Naphthaline, balls	lb.	.16 —	.18
Naphthionic acid, crude	lb.	.75 —	.85
Nitrobenzol	lb.	.14 —	.19
Nitro-naphthaline	lb.	.40 —	.50
Nitro-toluol	lb.	.18 —	.25
Ortho-amidophenol	lb.	3.25 —	4.25
Ortho-dichlor-benzol	lb.	.15 —	.20
Ortho-nitro-phenol	lb.	.80 —	1.25
Ortho-nitro-toluol	lb.	.25 —	.40
Ortho-toluidine	lb.	.35 —	.45
Para-amidophenol, base	lb.	2.50 —	3.00
Para-amidophenol, HCl	lb.	2.50 —	3.00
Para-dichlor-benzol	lb.	.08 —	.12
Paranitraniline	lb.	1.50 —	1.55
Para-nitro-toluol	lb.	1.35 —	1.50
Paraphenylenediamine	lb.	2.60 —	3.00
Paratoluidine	lb.	2.00 —	2.50
Phthalic anhydride	lb.	.65 —	.75
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.12 —	.20
Pyridin	gal.	2.00 —	3.50
Resorcin, technical	lb.	4.25 —	4.50
Resorcin, pure	lb.	6.25 —	6.75

Salicylic acid, tech., in bbls. (110 lb.)	lb.	$0 50	—	$0.52
Salicylic acid, U. S. P.	lb.	.50	—	.60
Salol	lb.	.90	—	1 00
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.25	—	.31
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.19	—	.24
Sulphanilic acid, crude	lb.	.28	—	.32
Toluidine	lb.	1.70	—	2.50
Toluidine, mixed	lb.	.45	—	.55
Toluol, in tank cars	gal.	.28	—	.....
Toluol, in drums	gal.	.29	—	.32
Xylidine, drums, 100 gal.	lb.	.44	—	.50
Xylol, pure, in drums	gal.	.37	—	.45
Xylol, pure, in tank cars	gal.	.35	—	.....
Xylol, commercial, in drums, 100 gal.	gal.	.37	—	.45
Xylol, commercial, in tank cars	gal.	.23	—	.27

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	$0.36	—	$0.39
Beeswax, refined, light	lb.	.39	—	.40
Beeswax, white pure	lb.	.63	—	.68
Carnauba, No. 1. (nominal)	lb.	1 00	—	1 05
Carnauba, No. 2, regular (nominal)	lb.	.85	—	.88
Carnauba, No. 3, North Country (nominal)	lb.	.43	—	.44
Japan	lb.	.21	—	.22
Montan, crude	lb.	.23	—	.25
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.09	—	.09½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.09½	—	.10
Paraffine waxes, refined, 118-120 m.p.	lb.	.11½	—	.12¼
Paraffine waxes, refined, 128-130 m.p.	lb.	.14½	—	.15
Paraffine waxes, refined, 133-135 m.p.	lb.	.16½	—	.17
Paraffine waxes, refined, 135-137 m.p.	lb.	.17¾	—	.18¼
Stearic acid, single pressed	lb.	.25	—	.26
Stearic acid, double pressed	lb.	.26	—	.27
Stearic acid, triple pressed	lb.	.27	—	.28

NOTE—Quotations on paraffine waxes are nominal.

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0.940	gal.	$1.80
Pine oil, pure, dest. dist.	gal.	1.60
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	.48
Pine tar oil, crude, sp. gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.35
Pine tar oil, double ref., sp. gr. 0.965-0.990	gal.	.85
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970	gal.	1.75
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.	.35
Pinewood creosote, ref.	gal.	.52

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl.	280 lb.	$17.50	—	$18.00
Rosin E-I	280 lb.	18.50	—	19.75
Rosin K-N	280 lb.	20.00	—	21.00
Rosin W. G.-W. W.	280 lb.	21.25	—	23.00
Wood rosin, bbl.	280 lb.	17.00	—	17.00
Spirits of turpentine	gal.	1.85	—	.....
Wood turpentine, steam dist.	gal.	1.70	—	1.80
Wood turpentine, dest. dist.	gal.	1.40	—	1.50
Pine tar pitch, bbl.	200 lb.	.....	—	8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	14.50	—	15.00
Retort tar, bbl.	500 lb.	15.00	—	15.50
Rosin oil, first run	gal.	.87	—	.89
Rosin oil, second run	gal.	.89	—	.92
Rosin oil, third run	gal.	1.04	—	1.05
Rosin oil, fourth run	gal.	1.12	—	1.12

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.40
70-72 deg., steel bbls. (85 lb.)	gal.	.38
68-70 deg., steel bbls. (85 lb.)	gal.	.37
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.29

Crude Rubber

Para—Upriver fine	lb.	$0.37½	—	$0.38
Upriver coarse	lb.	.28¼	—	.29½
Upriver caucho ball	lb.	.30	—	.30½
Plantation—First latex crepe	lb.	.38	—	.39
Ribbed smoked sheets	lb.	.38½	—	.39
Brown crepe, thin, clean	lb.	.37	—	.38
Amber crepe No. 1	lb.	.....	—	.40

Oils

VEGETABLE

The following prices are f.o.b., New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.18½	—	$0.20
Castor oil, AA, in bbls.	lb.	.20	—	.22
China wood oil, in bbls.	lb.	.18½	—	.19½
Cocoanut oil, Ceylon grade, in bbls.	lb.	.17½	—	.18½
Cocoanut oil, Cochin grade, in bbls (nominal)	lb.	.18½	—	.19½
Corn oil, crude, in bbls.	lb.	.17	—	.18
Cottonseed oil, crude (f.o.b. mill)	lb.	.15½	—	.16
Cottonseed oil, summer yellow	lb.	.18½	—	.19
Coteonseed oil, winter yellow	lb.	21	—	.22
Linsed oil, raw, car lots (domestic)	gal.	1.57	—	1.67
Linseed oil, raw, tank cars (domestic)	gal.	1.52	—	1.62
Linseed oil, boiled, car lots (domestic)	gal.	1.60	—	1.70
Olive oil, commercial	gal.	3.10	—	3.25
Palm, Lagos	lb.	.12½	—	.13½
Palm, bright red	lb.	.13	—	.13½
Palm, Niger	lb.	.11	—	.12
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.13	—	.15
Peanut oil, refined, in bbls.	lb.	.22	—	.24
Rapeseed oil, refined in bbls.	gal.	1.70	—	1.72
Rapeseed oil, blown, in bbls.	gal.	1.80	—	1.85
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	17	—	.18
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.12½	—	.13½

FISH

Winter pressed Menhaden	gal.	$1.17	—	$1.18
Yellow bleached Menhaden	gal.	1.20	—	1.22
White bleached Menhaden	gal.	1.23	—	1.24
Blown Menhaden	gal.	1.30	—	1.32

Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$22.00	—	$25.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	18.00	—	20.00
Barytes, crude, 88%@94% ba., Kings Creek	net ton	8.00	—	10.00
Barytes, ground, white, f.o.b. Cartersville, Ga.	net ton	23.00	—	25.00
Barytes, ground, off-color, f.o.b. Cartersville	net ton	16.00	—	19.00
Barytes, crude, 88%@94% ba., Cartersville	net ton	12.00	—	.....
Blanc fixe, dry	lb.	.05½	—	.06
Blanc fixe, pulp	net ton	60.00	—	80.00½
Casein	lb.	.15	—	.18
Chalk, domestic, extra light	lb.	.05	—	.06
Chalk, domestic, light	lb.	.04½	—	.05½
Chalk, domestic, heavy	lb.	.04	—	.05
Chalk, English, extra light	lb.	.05	—	.07
Chalk, English, light	lb.	.05	—	.06
Chalk, English, dense	lb.	.04½	—	.05
China clay (Kaolin) crude f.o.b. Virginia points	net ton	8.00	—	12.00
China clay (Kaolin) ground, f.o.b. Virginia points	net ton	15.00	—	40.00
China clay (Kaolin), imported, lump	net ton	25.00	—	35.00
China clay (Kaolin), imported, powdered	net ton	30.00	—	60.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	gross ton	7.50	—	8.00
Feldspar, ground, f.o.b. Baltimore	net ton	22.00	—	25.00
Feldspar, ground, f.o.b. North Carolina	net ton	16.00	—	20.00
*Feldspar, ground, f.o.b. N. Y. State	net ton	16.00	—	20.00
Fuller's earth, granular, f.o.b. Fla.	net ton	25.00	—	.....
Fuller's earth, powdered, f.o.b. Fla.	net ton	18.00	—	.....
Fuller's earth, imported, powdered	net ton	35.00	—	40.00
Graphite (dust polish grade 30%) Ashland, Ala.	lb.	.....	—	.01
Graphite (dust facing grade 50%) Ashland, Ala.	lb.	.....	—	.02
Graphite, crucible, 80% carbon Ashland, Ala.	lb.	.....	—	.05
Graphite, crucible, 90% carbon Ashland, Ala.	lb.	.....	—	.10
Graphite, crucible, 85% carbon	lb.	.....	—	.08
Graphite, crucible, 88% carbon	lb.	.....	—	.09½
Graphite, crucible, 90% carbon	lb.	.....	—	.10½
Pumice stone, imported, lump	lb.	.04	—	.50
Pumice stone, domestic, lump	lb.	.06	—	.....
Pumice stone, ground	lb.	.04	—	.07
Quartz (acid tower) fist to head, f.o.b. Baltimore	net ton	.....	—	10.00
Quartz (acid tower) 1½@2 in., f.o.b. Baltimore	net ton	.....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton	.....	—	17.00
Quartz, lump, f.o.b. North Carolina	net ton	5.00	—	7.50
Shellac, orange, fine	nominal lb.	1.40	—	.....
Shellac, orange, superfine	lb	1.50	—	.....
Shellac, A. C. garnet	lb.	1.05	—	1.15
Shellac, T.N.	lb.	1.20	—	1.30
Soapstone	ton	15.00	—	25.00
Talc, paper-making grades, f.o.b. Vermont	ton	9.50	—	14.00
Talc, roofing grades, f.o.b. Vermont	ton	8.00	—	9.00
Talc, rubber grades, f.o.b. Ve mont	ton	9.00	—	15.00
Talc, powdered, Southern, f.o.b. cars	ton	12.00	—	15.00
Talc, talcum powder grade, California	ton	20.00	—	35.00
Talc, imported	ton	60.00	—	70.00

Refractories

All f.o.b. Works:

Chrome brick, 9 in. straights and sizes	net ton	$80-90 at Baltimore
Chrome brick	net ton	75-80 at Chester, Penn.
Chrome cement	net ton	45-50 at Chester, Penn.
Clay brick, 1st quality fireclay	1,000	45-50 at Clearfield, Penn.
Clay brick, 2nd quality	1,000	40-45 at Clearfield, Penn.
Fire clay	net ton	5—7 at Baltimore
Magnesite, dead burned	net ton	50-55 at Chester, Penn.
Magnesite brick, 9 x 4½ x 2½ in.	net ton	85-90 at Chester, Penn.
Magnesite brick, 9 in. straights	net ton	90 at Baltimore
Magnesite brick, 9 in. sizes and shapes larger than 9 in.		Regular extras
Silica brick	1,000	50-55 at Mt. Union, Penn.
Silica brick, 9 in. straights, and sizes	1,000	55, Chicago District

Ferro-Alloys

All f.o.b. Works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00	—	$250.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon	lb.	.17	—	.18
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon	lb.	.18	—	.19
Ferro-manganese, 70-80% Mn	gross ton	200.00	—	250.00
Spiegeleisen, 16-20% Mn	gross ton	70.00	—	75.00
Ferro-molybdenum, 50-60% Mo, per lb. of Mo	lb.	2.25	—	2.75
Ferro-silicon, 10-15%	gross ton	60.00	—	65.00
Ferro-silicon, 50%	gross ton	80.00	—	90.00
Ferro-silicon, 75%	gross ton	150.00	—	160.00
Ferro-tungsten, 70-80%, per lb. of contained W	lb.	.90	—	1.10
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	7.00	—	.....
Ferro-vanadium, 30-40% per lb. of contained V	lb.	6.50	—	7.75

Ores and Semi-finished Products

All f.o.b. Mines, Unless Otherwise Stated

Carnotite 96% U_3O_8, per lb. of U_3O_8	lb.	$2.75	—	$3.00
Chrome ore, Calif. concentrates, 50% min., Cr_2O_3	unit	.60		.65
Chrome ore, 40%, min., Cr_2O_3 f.o.b. Atlantic Seaboard	unit	.70	—	.85
Coke, foundry, f.o.b. ovens	net ton	16.00	—	17.00
Coke, furnace, f.o.b. ovens	net ton	15.00	—	16.00
*Coke, petroleum, refinery, Atlantic Seaboard	net ton	24.00		
Fluor spar, gravel	net ton	22.50	—	25.00
Fluor spar, lump, f.o.b. Tonuco, New Mexico	net ton	17.50	—	.....
Ilmenite, 52% TiO_2, per lb. ore	lb.	.02	—	.....
Manganese ore, 45% Mn and over	unit	.80	—	.85
Manganese ore, chemical (MnO_2)	gross ton	75.00	—	85.00
Molybdenite, 85% MoS_2, per lb. of MoS_2	lb.	.85	—	.....
Monazite, per unit of ThO_2	unit	42.00	—	.....
Pyrites, Spanish, fines, c.i.f.	unit	.12	—	.....
Pyrites, Spanish, furnace size, c.i.f.	unit	.16½	—	.....
Pyrites, Spanish, run of mines, c.i.f.	unit	.12	—	.14
Pyrites, domestic, fines	unit	.12	—	.14
Rutile, 95% TiO_2 per lb. ore	lb.	.20	—	.25
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3	unit	7.00	—	.....
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3	unit	6.50	—	7.50
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.75	—	3.00
Vanadium pentoxide, 99%	lb.	12.00	—	14.00
Vanadium are per lb. of V contained	lb.	1.00	—	3.00
Zircon, washed, iron free	lb.	.10	—	.....

*Nominal

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

California

LOS ANGELES—The Robertson Cole Studios, Inc., Currier Bldg., has awarded the contract for the construction of a moving picture studio on Gower St. and Melrose Ave., to the Milwaukee Bldg. Co., 403 South Hill St. A chemical laboratory will be installed in same. Estimated cost, $100,000.

SAN PEDRO—The Fabri-Cord Tire Co., 917 Natl. Bank Bldg., Los Angeles, has purchased a site on 17th St. and plans to build a 3-story, 60x250-ft. factory on same. Estimated cost, $2,000,000. S. H. Christian, pres.

Connecticut

FAIRFIELD—The Bridgeport Deoxidized Bronze & Metal Co., Iran Ave., has purchased a 23-acre site along the New York, New Haven & Hartford R.R., here, and plans to construct a large bronze factory on same.

MONTVILLE—The Robert Gair Paper Corp., Thames River Division, will soon award the contract for the construction of a 2-story, 250x400-ft. manufacturing building. Estimated cost, $500,000.

Illinois

CHICAGO—The Kroeck Paper Co., 220 Institute Pl., is building a plant at Paulina and Superior Sts. Estimated cost, $240,000.

Indiana

WEST HAMMOND—R. G. Pierce, archt., 10 South La Salle St., Chicago, will soon award the contract for the construction of a 1-story, 210x560-ft. steel plant, here, for the La Salle Iron Works, 2305 South Halsted St., Chicago. Rolling mill, heat treatment and pickling equipment will be installed in same. Estimated cost, $650,000.

Iowa

HAWARDEN—The Bd. Educ. rejected all bids for the construction of a 2-story, 60x150-ft. school including chemical and physical laboratories. Estimated cost, $135,000. G. L. Lockhart, 391 Endicott Bldg., St. Paul, Minn., archt.

Maine

CARIBOU—The Aroostook Federation of Farmers plans to build a large fertilizer plant here. Estimated cost, $50,000.

Maryland

BALTIMORE—The Natl. Enameling & Stamping Co., Race and Ostend Sts., has awarded the contract for the construction of a 2-story, 61x76-ft. addition to its tin stamping factory, to the John Waters Bldg. Co., 23 East Center St., at $100,000.

Massachusetts

CAMBRIDGE—The Ltd. Plate Glass Co., 30 Sudbury St., Boston, has awarded the contract for the construction of a 2-story, 100x200-ft. factory on Albany St., to N. H. & H. A. Root, 6 Beacon St., Boston.

Michigan

DETROIT — The International Metal Stamping Co., Artillery & Muster Aves., has awarded the contract for the construction of a 1-story, 79x532-ft. factory on Artillery Ave., to the H. G. Christman Co., 315 Stevens Bldg., at $130,000. Noted June 9.

Missouri

BROOKFIELD—The School Bd. plans to build a school. A general chemical laboratory will be installed in same. Estimated cost, $105,000. A. W. Baker, secy. W. E. Hulse & Co., 309 Securities Bldg., Des Moines, Ia., archt.

NEVADA—T. B. Craig, Supt. of State Hospital 3, will receive bids until July 1 for the construction of a 2-story, 40x80-ft. hospital. A bacteriological laboratory will be installed in same. Estimated cost, $65,000.

New York

GREYCOURT—The Dept. of Correction, Municipal Bldg., New York City, rejected all bids for furnishing all labor and material for the construction of a sewage disposal plant for the New York Women's Farm Colony here. Work will be re-advertised. Noted May 5.

North Dakota

BISMARCK—The Bd. of City Comrs. will receive bids until July 12 for the construction of a complete waterworks system, including a 79x114-ft. filtration plant and a 73x113-ft. sedimentation basin, rapid sand filters of 750,000-gal. capacity, dry feed chemical machines, etc.

JAMESTOWN—The Bd. Educ. is having plans prepared for the construction of a 3-story, 230x240-ft. junior high school. A chemical laboratory will be installed in same. Estimated cost, $200,000. Shannon Boyd & Boyd, archts.

Ohio

AKRON—The city received only bid for furnishing sulphate and aluminum to the bureau of water service and water supply, Dept. of Pub. Serv., from the General Chemical Co., 112 North Adams St., $25,800.

AKRON—E. A. Zeisloft, Dir. of Pub. Serv., Delaware Bldg., will receive bids until July 9 for the construction and equipment of an addition to the water purification plant. Filter equipment will be installed in same.

GARRETTSVILLE—The McWade Tire & Rubber Co., 711 Union Bldg., Cleveland, plans to build a 2-story rubber factory here. Estimated cost, $75,000.

MASSILLON—The Alloy Electric Steel Castings Co. has awarded the contract for the construction of a 1-story, 50x150-ft. mill building, to the Boldt Constr. Co., 6110 Euclid Ave., Cleveland, at $60,000.

WORTHINGTON — W. P. Vest, village clk., will soon award the contract for the construction of a sewage disposal plant for the city. Jennings, Laurence Co., Hartman Bldg., Columbus, engrs.

Texas

BRIDGEPORT—The Phoenix Clay Corp., 1215 Southwestern Life Bldg., Dallas, plans to build a brick and tile plant here, which will have a daily capacity of 125,000 brick or 150 tons of tile. Address C. W. Martin, pres.

FARMERSVILLE—The Bd. of Directors of the Farmersville Sewer Co. has awarded the contract for the construction of sanitary sewer lines and 2 sewage disposal plants, to J. W. Crook, Paris, at $43,856. Noted June 16.

Wisconsin

MILWAUKEE—The Amer. Metal Products Co., Clinton St. and Kinnickinnic Ave., has purchased a 6-acre site on Burham St. and plans to construct a modern 80x220-ft. foundry on same. Later the company plans to build a rolling mill. C. J. Zarse, genl. mgr.

MILWAUKEE—The Supt. of Lighthouses will soon award the contract for furnishing and delivering acetylene gas in acetone, gasoline, kerosene, etc.

PORT WASHINGTON—The Turner Mfg. Co. will soon award the contract for the construction of a 1-story, 150x160-ft. foundry and factory addition. Frank D. Chase, Inc., 645 North Michigan Ave., Chicago, archt. Noted June 23.

New Brunswick

MONCTON—The Record Fdry. & Machine Co., Ltd., plans to build a 50x140-ft. foundry. Estimated cost, $75,000. H. G. Jackson, mgr.

Ontario

KANORA—The St. Francis Pulp & Paper Co. will soon receive bids for the construction of a pulp and paper mill along the English River north of here. Estimated cost, $500,000.

LONDON—The city plans to supply St. Thomas and London with water from Lake Erie. Estimated cost of pipe line, $3,000,000. Plans include a filter plant at an annual charge of $500,000.

Coming Meetings and Events

THE AMERICAN CERAMIC SOCIETY will hold its summer meeting at the La Salle Hotel in Chicago, Aug. 16, 17 and 18.

THE AMERICAN CHEMICAL SOCIETY will hold its fall meeting in Chicago, Sept. 7 to 10 inclusive.

THE AMERICAN ELECTROPLATERS' SOCIETY will hold its eighth annual convention in Rochester, June 30 to July 3. Headquarters will be at the Seneca Hotel.

THE AMERICAN FOUNDRYMEN'S ASSOCIATION will meet in Columbus, Ohio, Oct. 4 to 8 inclusive.

THE AMERICAN INSTITUTE OF CHEMICAL ENGINEERS is holding its twelfth semi-annual meeting as follows: June 28 and 29 in Montreal, June 30 in Ottawa, July 1 in Ontario, July 2 in Shawinigan Falls, July 3 in La Tuque, July 4 in Chicoutimi and July 5 in Quebec.

THE AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its one hundred and twenty-second meeting Aug. 20 to Sept. 3, at Lake Superior.

THE AMERICAN MINING CONGRESS will hold its next convention in Denver Nov. 15.

THE AMERICAN PHYSICAL SOCIETY will hold a meeting Nov. 27 at the Case School of Applied Science, Cleveland, and the annual meeting, beginning Dec. 28, at Chicago, the latter being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

THE AMERICAN STEEL TREATERS' SOCIETY, Chicago, will hold its second annual convention and exhibit, combined with the convention of the Steel Treating Research Society of Detroit, Mich., in the Coliseum Museum, Philadelphia, Pa., Sept. 14 to 18 inclusive.

THE FOREST PRODUCTS LABORATORY will hold its decennial celebration at Madison, Wis., July 22 and 23, 1920.

THE INSTITUTE OF METALS DIVISION OF THE A.I.M.E. will hold its usual joint meeting with the American Foundrymen's Association at Columbus, Ohio, during the week beginning Oct. 4.

THE INSECTICIDE AND DISINFECTANT MANUFACTURERS' ASSOCIATION will hold its midsummer meeting at Boston, July 15 and 16.

THE IRON AND STEEL INSTITUTE (British) will hold its autumn meeting at Cardiff by invitation of the Ironmasters and Steel Manufacturers of South Wales and Monmouthshire. The date of the meeting will be Tuesday, Sept. 21, for the assembling of the members at Cardiff, and the formal proceedings will open on the morning of Wednesday, Sept. 22.

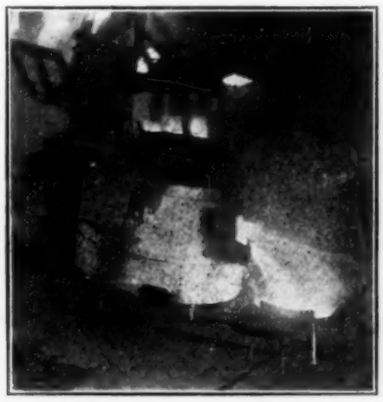
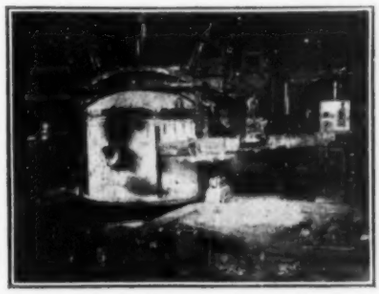
THE SIXTH NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES will be held in the Grand Central Palace, New York City, Sept. 20 to 25.

THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION will hold its twenty-seventh annual meeting June 29 to July 3, at the University of Michigan, Ann Arbor, Mich.

THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY will hold its fall meeting at Saratoga Springs, N. Y., Sept. 1, 2 and 3.

New Publications

NEW BUREAU OF MINES PUBLICATIONS: Bull. 78, Approved Explosion-Proof Coal-Cutting Equipment, by L. C. Ilsley and E. J. Gleim; Bull. 95, A Glossary of the Mining and Mineral Industry, by Albert H. Fay; Bull. 140. Occupational Hazards at Blast-Furnace Plants and Accident Prevention, by Frederick H. Willcox; Bull. 183. Abstract of Current Decisions on Mines and Mining, by J. W. Thompson; Tech. Paper 227, The Determination of Mercury, by C. M. Bouton and L. H. Duschak; Blowholes, Porosity and Unsoundness in Aluminum-Alloy Castings, by Robert J. Anderson; Tech. Paper 245, Quarry Accidents in the United States During the Calendar Year 1918, by Albert H. Fay; Tech. Paper 250, Metal-Mine Accounting, by C. B. Holmes; Tech. Paper 252, Metal Mine Accidents in the United States During the Calendar Year 1918, compiled by Albert H. Fay.

The power consumption in an Electric Furnace depends chiefly on the character of the product and the methods of the operator.

The use of Acheson Electrodes, under the same conditions as other electrodes, will show a reduction in the amount of power required. This means a corresponding reduction in the cost per ton of steel.

Coincident with this saving in power is the shortening of the time necessary to make each heat, which of course increases production.

ACHESON GRAPHITE COMPANY

Niagara Falls, N. Y., U. S. A.

E. G. Acheson, Ltd., 40 Wood St. Westminster, London, S. W. 1, England
Takamine Shoji Kaisha, Tokyo Kaijo Bldg., Tokyo, Japan

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Laboratories and Testing Plant

Preliminary testing is essential in determining the best design for a plant.

The Westport Mill is equipped for extended research along various lines; particularly the investigation, development or testing of chemical and metallurgical processes. The equipment is especially adapted to processes involving the separation, dewatering or washing of solids carried in suspension in liquids.

The Dorr Technical Staff has had a very broad and diversified experience to draw upon in the interpretation of the data obtained and in the development of practical working methods.

To make our service complete we design plants and supervise their erection and initial operation.

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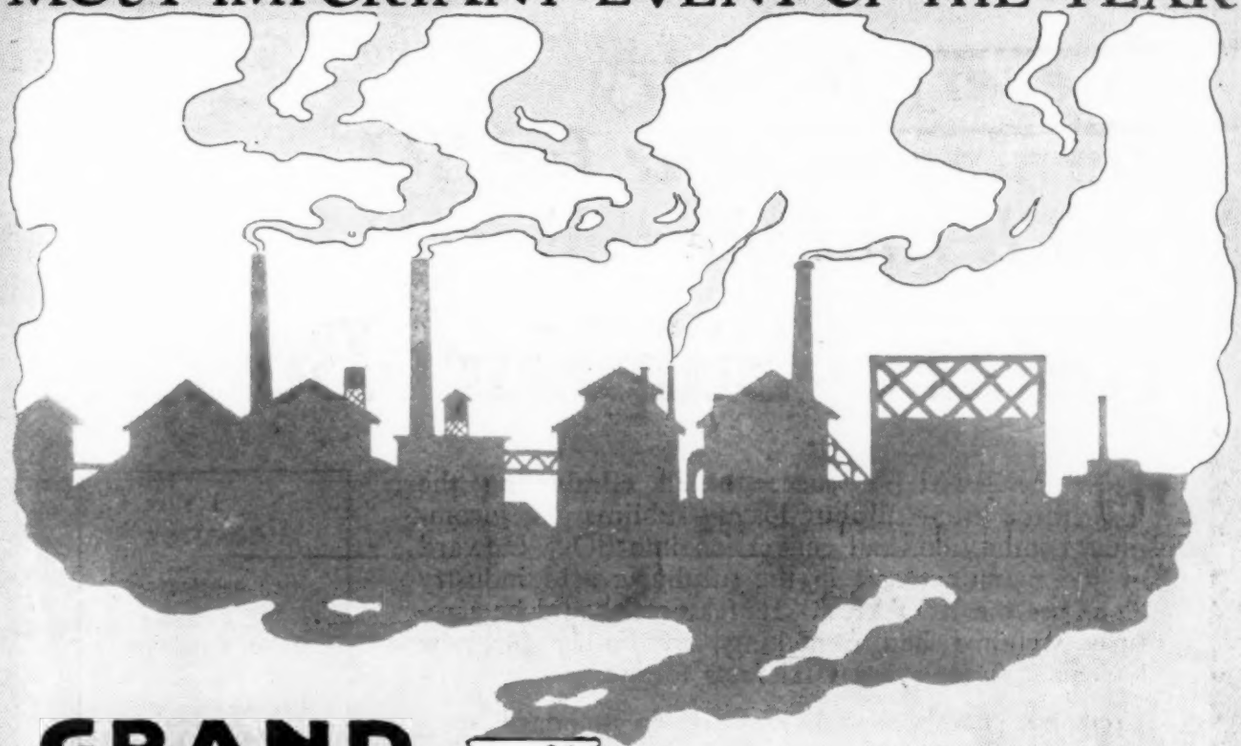
When in New York visit our booth at the
Permanent International Machinery Exposition, Grand Central Palace

MOST IMPORTANT EVENT OF THE YEAR



GRAND CENTRAL PALACE

NEW YORK

WEEK OF SEPT. 20 -1920-

SIXTH

EXPOSITION CHEMICAL INDUSTRIES

For further particulars, address
National Exposition Chemical Industries, *Grand Central Palace, New York*

In every Industry burning sulphur for SO_2 you'll find the

Rotary Sulphur Burner

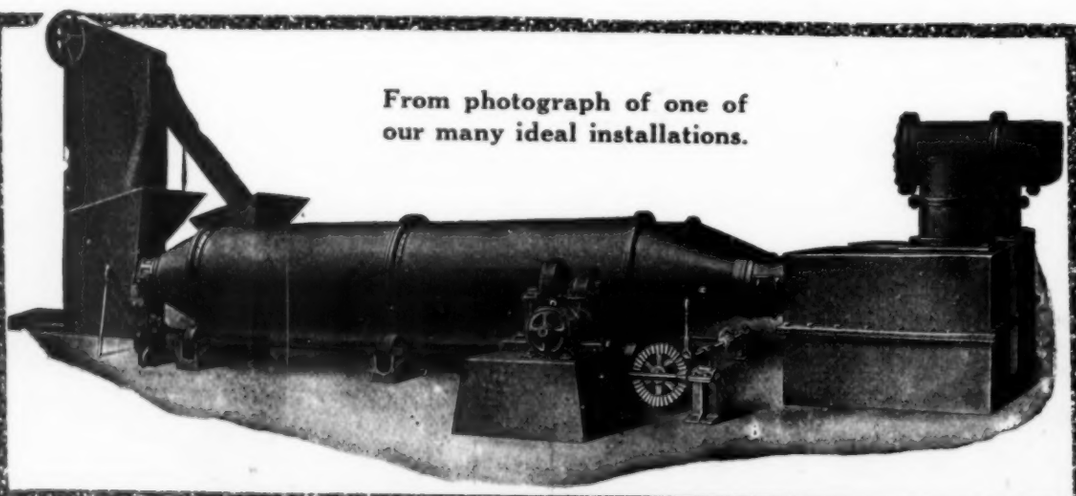
UNIVERSALLY successful in eliminating the three usual sulphur losses—sublimation, incomplete combustion, and conversion into SO_3. Upward of 100 manufacturers in the sulphuric acid industry alone use the ROTARY. Its features should be carefully weighed before making any outlay for new burners. A few very vital facts follow.

Used by chamber acid plants for fertilizer and in sugar refining, copper leaching, grain bleaching, extraction of tankage, fats, etc. No fumes, dust or dirt. Extremely simple to operate. Impossible to clog patented feed.

Built in standard sizes burning from 15 to 1200 lbs. per hour. Either worm or spur reducing gear drives for direct motor connection. Every installation means increased production. You cannot afford not to investigate.

Features

- High concentration
- Uniform strength of gas
- Greater production
- Clean white acid
- Less chamber space
- Very low labor cost
- Maximum yield
- Minimum repairs

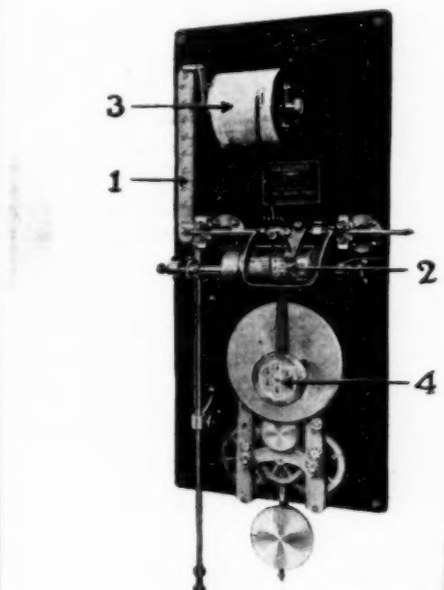


From photograph of one of our many ideal installations.

Consult us freely at any time. Suggestions, floor plans, etc., gladly furnished.

GLENS FALLS MACHINE WORKS, Glens Falls, N.Y.

YARWAY-LEA V-Notch METER



WHERE a manufacturing process involves the measurement of liquids, greater efficiency and lower costs may often be secured by the use of a recording liquid meter. The recording mechanism of the *Yarway-Lea V-Notch Meter* automatically furnishes four kinds of information (see illustration):

1. Inches head of flow falling over weir.
2. Instantaneous indication of rate of flow.
3. Graphic paper record in pounds or gallons of liquid during any part of 24 hours.
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The chart on the recorder enables regulation of the proportional amount of substances which may form a part of the finished product. Consult your chemist and our engineers regarding the value of a Yarway-Lea V-Notch Meter for your plant.

Several thousand in use throughout the world.

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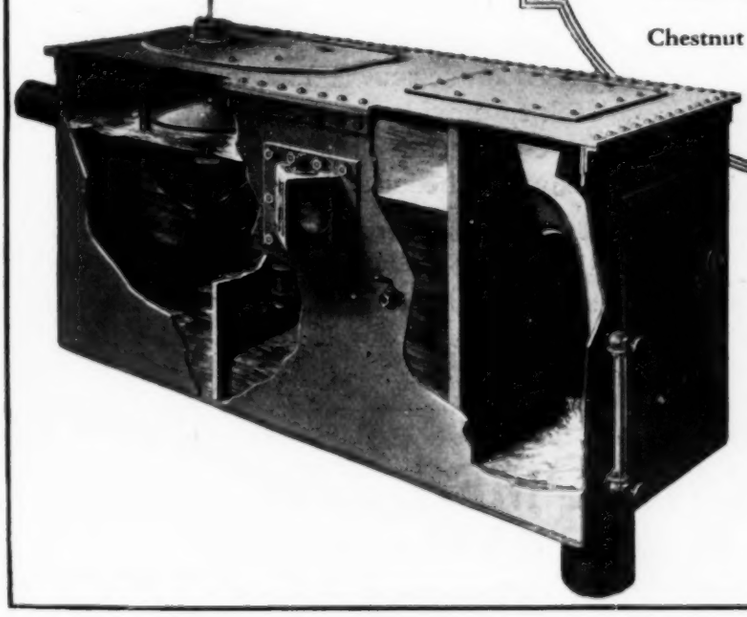

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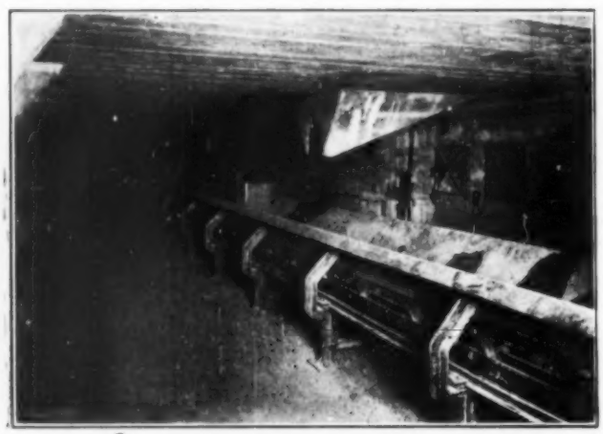
A Friendly Word of Warning about

WEBSTER

Labor-Saving Machinery



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We build practically every form of conveying and elevating machinery used to move products and merchandise in connection with industrial operations. The service of Webster Machinery in connection with coal handling and ash disposal systems for power plants is exceptionally noteworthy. Furthermore, we build and design many forms of power transmission equipment—drives, clutches, sheaves, etc.

DAILY manufacturers and all large operators are coming to appreciate more and more the vital need and advantages of the mechanical handling of products during process, and in connection with loading and storage, etc.

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We are doing our best to supply all who call upon us, at the same time we will never sacrifice the grade of Webster Equipment regardless of the urgency of the demand.

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Those who are fore-warned can safeguard their interests by acting quickly. We suggest, therefore, that if you have requirements in our line, you start negotiations at once.

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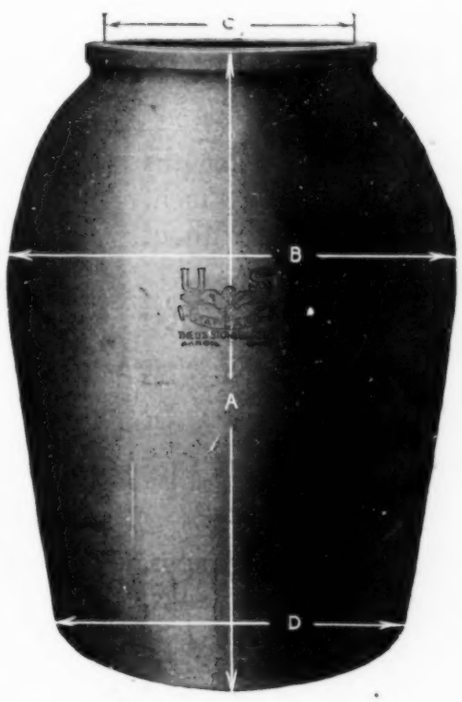

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TUBES of **uniform bore and straight,** in lengths up to ten feet and bore from 1/32 inch to 4½ inch. Open or closed ends, glazed or unglazed, with or without transparent section, reduced ends, etc.

EVAPORATING DISHES in sizes up to 22,500 ccm.

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MUFFLES all shapes up to 21 by 5 by 4 inches.

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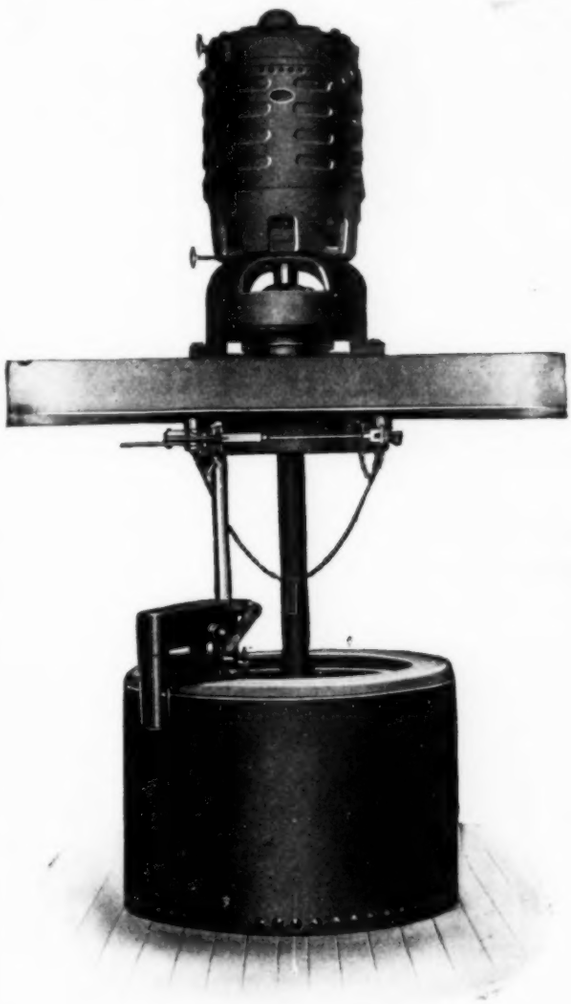

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When your extractor is put out of commission through breakage or wear, the cost of repair parts is but the smallest loss sustained. Your output is reduced and material in process may be lost through deterioration.

This is particularly true in the cane sugar industry. The mills are usually located in tropical countries where it takes months for repair parts to reach the machines where they may be urgently needed. MACKINTOSH CENTRIFUGALS have obtained a wide popularity in this industry because the repair and replacement items have been reduced to a minimum. That our customers' confidence has not been misplaced is shown by the fact that hundreds of our centrifugals have been operated continuously for periods up to ten years without needing any repair parts.

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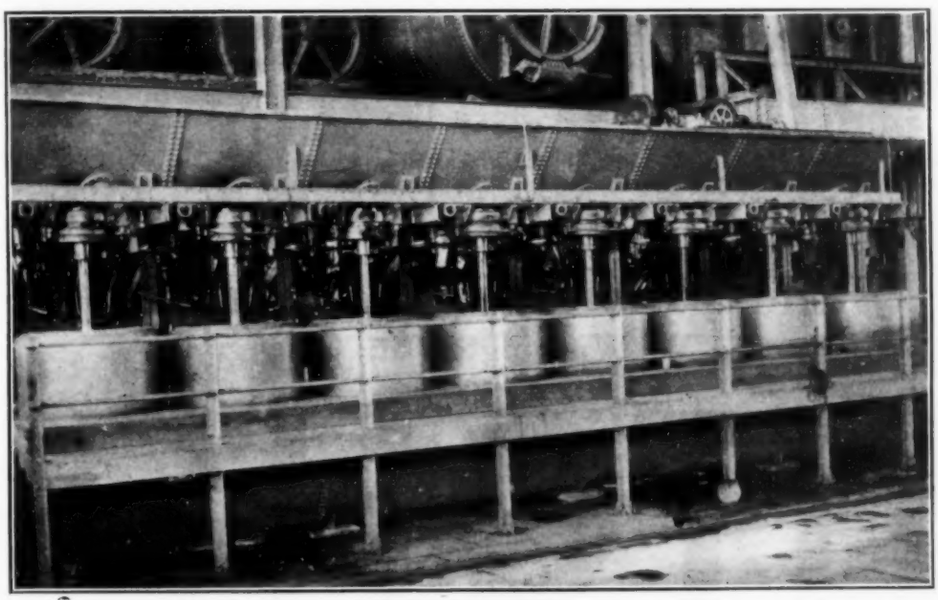

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There are several convincing reasons why you always may depend upon the high quality of Mitchell Lime:

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Manufactured in both the lump form and the hydrated form, Mitchell is the standard lime in the chemical and metallurgical industries.

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Hercules Chemicals

Hercules Soluble Cotton

Hercules Soluble Cotton is uniform, completely soluble, stable and absolutely free from acidity and foreign matter. Due to the unvaried purity of this cotton it will pass the rigid specifications required by the United States and British Governments.

Hercules Soluble Cotton is prepared in any viscosity and can be supplied with a wide range of nitrogen content. Solutions made from it are long flowing, free from granulation and precipitation, good in color, clear, and will carry a large quantity of non-solvents.

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- Soluble Cotton Solutions
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- Split Leather Dopes
- Dress Shield Solutions
- Ethyl Acetate Solutions
- Amyl Acetate Solutions
- Heavy Base Solutions
- Waterproof Belt Cement
- Film Cement
- Lacqer Bases
- Thinners

CHEMICALS

- Dinitrotoluol (D. N. T.)
- Valeric Acid
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  - Zinc Valerate
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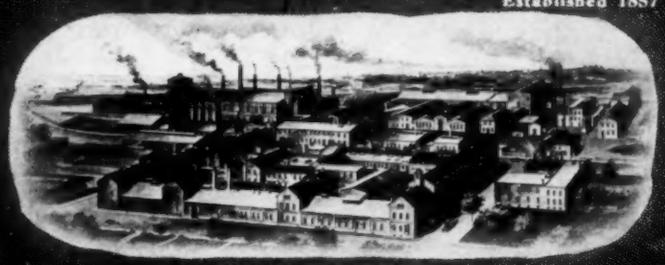

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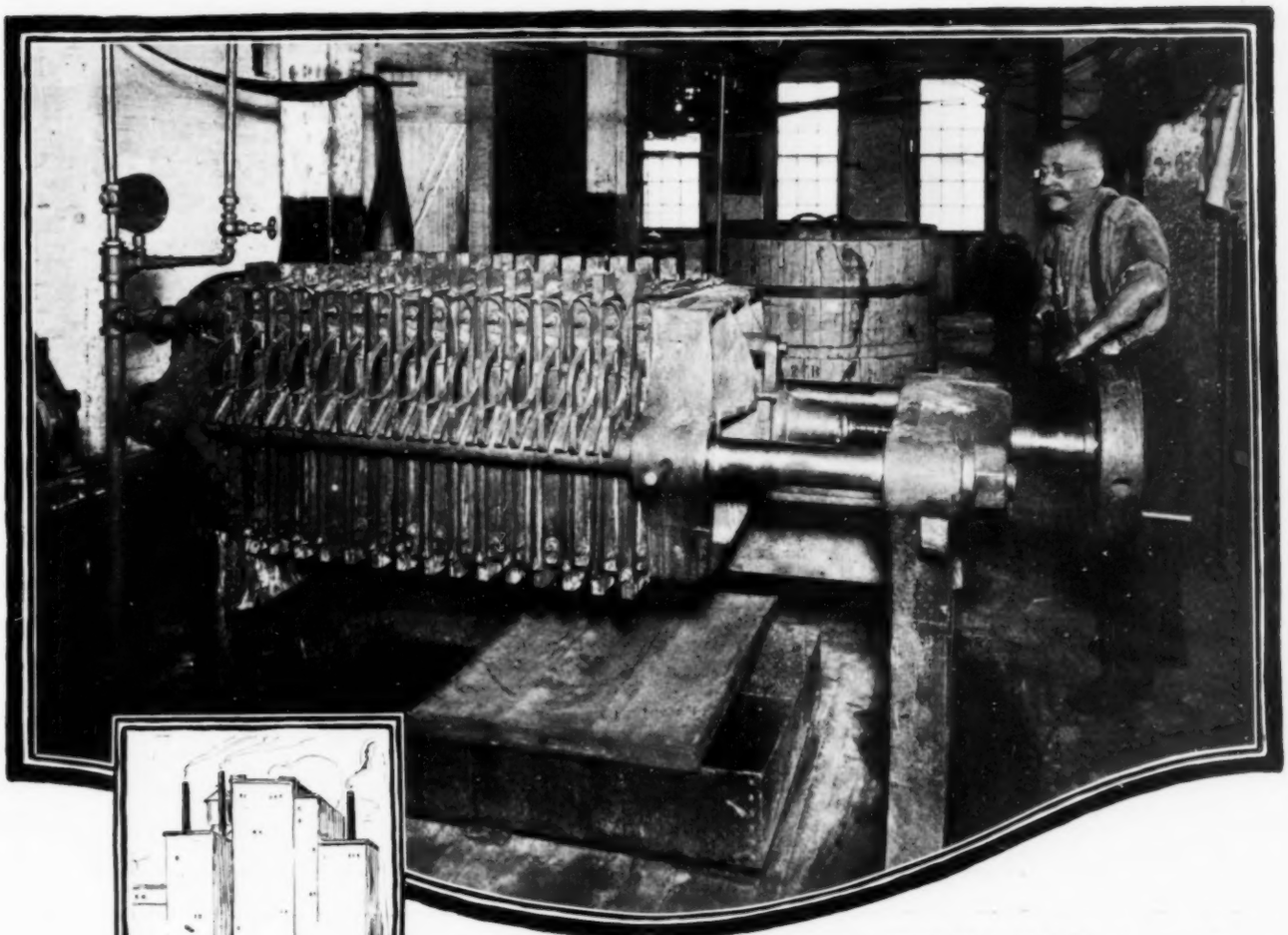

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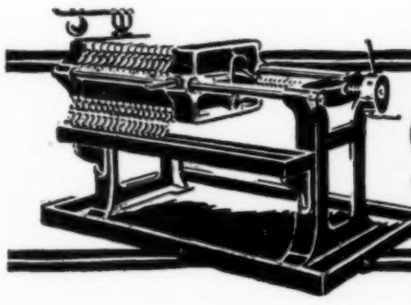

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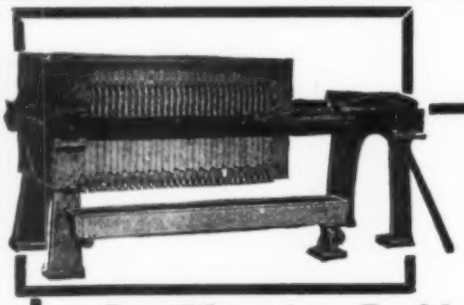

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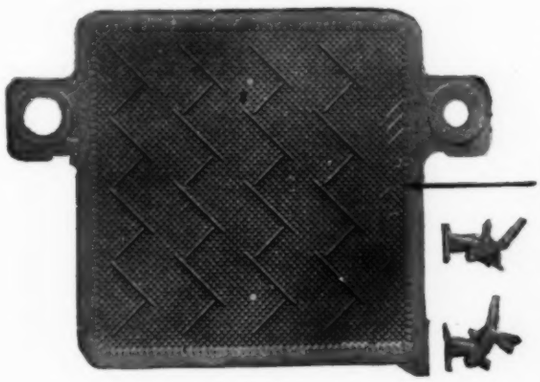

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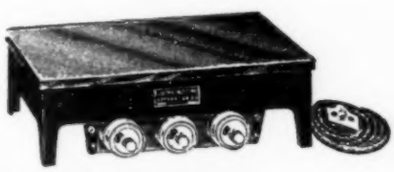

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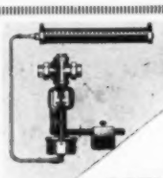

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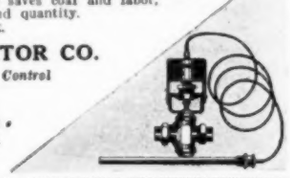

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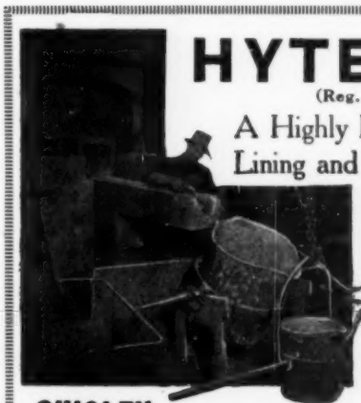

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more than a "Stoker," a complete system of scientific combustion

American Engineering Company, Philadelphia, Pa.

The Taylor Stoker Co., Ltd., Toronto, Canada.

FREAS ELECTRIC OVENS

are made in several sizes and styles. Approved by National Board of Fire Underwriters. Used by most important laboratories of the Federal Government, educational, scientific and manufacturing plants at home and abroad.

THERMO ELECTRIC INSTRUMENT COMPANY

8 Johnson St., Newark, N. J., U. S. A.

American Transformers

They're "Custom Made"

100,000 volt Transformer for Cottrell System of Precipitation.

Laboratory Furnace Transformer

The research worker in the chemical, metallurgical or experimental laboratory requires transformers built to meet his special needs.

For many years we have been building these "Custom Made" transformers and our organization is equipped to handle your problems, no matter how difficult.

Why try to use an ordinary transformer for "special uses?" This is sure to prove unsatisfactory and may entail loss of product, high cost of production and expensive delays.

Let us figure on your requirements.

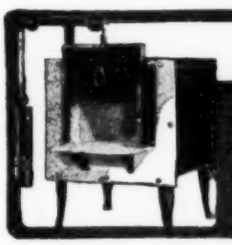
The American Transformer Company

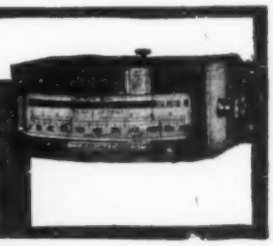
Office and Works:

182 Emmet Street, Newark, N. J.

HOSKINS

ELECTRIC FURNACES - PYROMETERS





Hoskins Electric Furnaces and Pyrometers are found in the majority of modern plants and their laboratories. Write to Hoskins Manufacturing Company Detroit, for complete information.

The Wedge Mechanical Furnace (Ptd.)

For Roasting Refractory Ores

The Wedge Mechanical Furnace Co.

Greenwich Point, Philadelphia

Laboratory Supplies Oil Burners

Fire Clay Products DFC Metallurgical Furnaces

THE DENVER FIRE CLAY COMPANY

Denver, Colorado, U. S. A.

New York Office: 50 E. 41st St. Utah Dept., Salt Lake City

Monel metal

Non-corrodible—strong as steel—tough and ductile. Withstands acids, high temperatures, erosive action of hot gases and superheated steam.

THE INTERNATIONAL NICKEL COMPANY,

43 Exchange Place, New York, N. Y.

Lead Lined Vacuum Apparatus

OAKLAND COPPER & BRASS WORKS

7th and Kirkham Sts. Oakland, Calif.

REDMANOL

Perfect Moulded Insulation

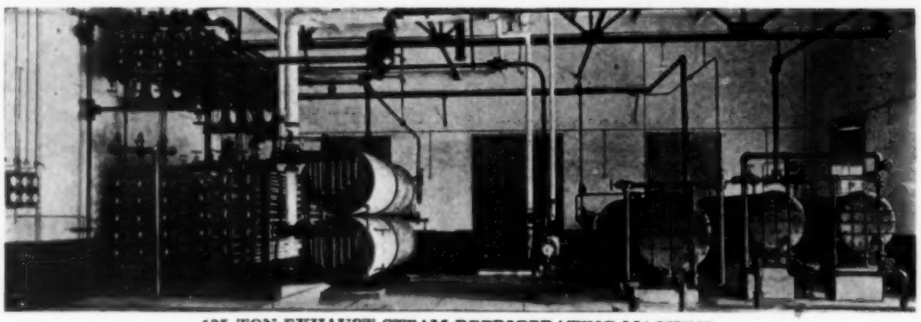
It excels in

Heat Resistance
Dielectric Strength
Mechanical Strength
Acid Resistance
Accuracy of Dimensions

Radiator Caps

Redmanol Chemical Products Co.

645 W. 22nd St., Chicago, Ill.



125 TON EXHAUST STEAM REFRIGERATING MACHINE

Vogt

Positive Control Refrigeration

is a method of maintaining constant temperature without constant attendance. It gives complete dependable control of the chemical processes for which it is used. This most efficient and necessary feature for best results in refrigeration has made Vogt Equipment the favorite with the leading Chemical Industries.

The economical advantages of Vogt Machinery are assured by its salient features—Reliability—Adaptability—Lasting Quality of Material—Master Workmanship.

Our Engineering Staff is at your service for solving your refrigerating problems.

HENRY VOGT MACHINE CO., LOUISVILLE, KENTUCKY
MANUFACTURERS
BRANCH OFFICES—NEW YORK, CHICAGO

ELEVATORS AND CONVEYORS

For handling raw or finished material.

Screw, belt, apron, pan, and cable conveyors.

Bucket elevators with or without casings.

H. W. CALDWELL & SON CO.
17th St. and Western Ave., CHICAGO
50 Church Street, New York City.
709 Main Street, Dallas, Texas.

EDIBLE OIL

SOLVENT EXTRACTION PLANTS
GLYCERINE RECOVERY
OIL-REFINING - BLEACHING - DEODORIZING PLANTS
TANKS
DRYERS
EVAPORATORS
HY-PRESSES
FILTER PRESSES

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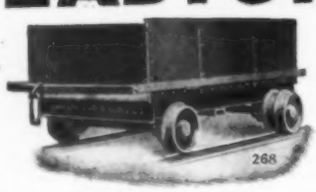
MANUFACTURED BY
REDFIELD MECHANICAL COMPANY
820 Exchange St., Union Stock Yards
CHICAGO

EASTON CARS

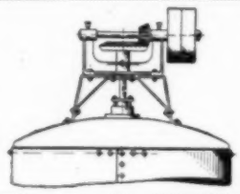


Skip cars for any purpose, to meet any conditions—this type is but one of a hundred or more kinds of industrial cars for every service.

Tell us what you move.

EASTON CAR & CONST'N CO.

47 Dey St., New York—Works: Easton, Pa.
Boston Chicago Detroit Philadelphia Pittsburgh



Agitator Driving Yokes

No. 313 for closed tanks and kettles with dished head. Easily mounted on legs forged to suit container.

Bulletin 1-C.

Nickle Engineering Works
Saginaw, Mich.

YORK MANUFACTURING CO.

YORK, PA.

Refrigerating Plants for the Chemical Industry

Ammonia Compression
Ammonia Absorption
CO_2 Compression.

Consultation on any Refrigerating Problem Invited.

CHEMICAL AND METALLURGICAL ENGINEERING

Think "SEARCHLIGHT" First

ADVERTISING RATES

POSITIONS VACANT—Business Opportunities and other undisplayed ads, 8 cents a word, minimum $2.00 an insertion.

POSITIONS WANTED—Evening work wanted, tutoring and other undisplayed ads of individuals looking for employment, 4 cents a word, minimum 75 cents, **payable in advance.**

ADD 5 WORDS for box number in undisplayed ads if replies are to any of our offices. There is no extra charge for forwarding replies.

DISCOUNT OF 10% if one payment is made in advance for 4 consecutive insertions of undisplayed ad.

ADS IN DISPLAY TYPE—Space is sold by the inch (30 in. to a page), the price depending upon total space used within a year, some space to be used each issue.

RATE PER INCH for ads in display space:

1 to 3 in., $4.50 an in.	15 to 29 in., $3.90 an in.
4 to 7 in., $4.30 an in.	30 to 49 in., $3.80 an in.
8 to 14 in., $4.10 an in.	50 to 99 in., $3.70 an in.

POSITIONS VACANT

EMPLOYMENT

POSITIONS WANTED

POSITIONS VACANT

CHEMIST, familar with market conditions of chemicals, to handle market pages of of a chemical trade publication in New York. Some experience in writing or newspaper work necessary. State all qualifications, salary wanted, etc., in first letter. P-778, Chem. & Met. Engrg.

GRADUATE chemist thoroughly experienced in the commercial manufacture of Azo dyes. Must be able to produce Azo dyes of the highest quality and be capable of taking complete charge of this department. To chemist who can prove his ability and to whom opportunity rather than initial salary is the chief consideration, a very attractive position is open. State experience in detail and salary expected. Information given will be strictly confidential. P-779, Chem. & Met.

HIGH-CLASS mechanical draftsman wanted for refinery design and detailing; neat, accurate and experienced, preferably in oil, piping or boilershop work. Also engineer with several years' experience and ability in design. Give full details, education, experience and salary; good opportunity. Apartado No. 162, Tampico, Mexico.

MAN with technical education wanted, experienced in the operation of industrial fermentation processes. Only those actually having had such experience will be considered. P-766, Chem. & Met.

SUPERINTENDENT for wood distillation plant located abroad. P-791, Chem. & Met. Engrg.

YOUNG chemical engineer wanted as general assistant to works manager in developing manufacturing business. Must be prepared to undertake analysis, research or plant work as required; engineering and drafting experience desirable. National Oil & Products Co., Harrison, New Jersey.

EMPLOYMENT SERVICE

EXECUTIVES qualified for salaries of $2500 to $25,000 and upwards, are invited to communicate in strict confidence with the undersigned, who will conduct preliminary negotiations for such positions. The procedure used is peculiar to this service, differing essentially from all others; and is constructive and initiative; applied individually; and in no way jeopardizing present connections. Established 1910. Send name and address only for particulars. R. W. Bixby, Inc., 312 Lockwood Building, Buffalo, New York.

PRATT INSTITUTE
Brooklyn, N. Y.
School of Science and Technology
Industrial Chemical Engineering
Industrial Electrical Engineering
Industrial Mechanical Engineering
Intensive Two-Year Technical Courses expressly designed to afford an efficient training in the shortest time consistent with thoroughness. Low tuition. Liberal entrance requirements.
Circular of Information on request

In Replying to "Blind" Ads

number in the ad and also local address be careful to put on envelope the key of office to which reply is sent.

10th Ave. at 36th St., New York.
935 Real Estate Trust Bldg., Phila.
533 Leader-News Bldg., Cleveland.
1570 Old Colony Bldg., Chicago.
531 Rialto Bldg., San Francisco.

Important

Original letters of recommendations or other papers of value should not be enclosed to unknown correspondents — send copies.

POSITIONS WANTED

CHEMICAL engineer, university graduate, age 26; 2½ years' experience in organic research and plant operation, desires position in similar capacity with company who demands results; business education, alive; moderate salary to begin. PW-734, Chem. & Met., Leader-News Bldg., Cleveland.

CHEMICAL engineer, good executive, experience white and red metals, paints, pigments and heavy chemicals; present employed; desires new connection. PW-744, Chem. & Met.

CHEMICAL engineer, 27, university graduate; five years' experience in investigation, construction, operation of chemical and electrochemical plants. Desires position in or near New York City. Salary $200 per month. PW-750, Chem. & Met.

CHEMICAL engineer, 1920 graduate Eastern university, age 22, usual training, average intelligence, desires position. PW-789, Chem. & Met. Engrg., Real Estate Trust Bldg., Philadelphia.

CHEMICAL engineer, graduate Columbia; several years' experience intermediates, dyes and pharmaceuticals, both in laboratory and plant; capable of directing both research and large scale production. Have had selling experience and possess practical executive ability; desires position on technical staff of progressive concern. PW-783, Chem. & Met. Engrg.

CHEMIST, age 24; analytical, electroplating, plant control and manufacturing experience; would like to locate in New York City or vicinity. PW-793, Chem. & Met. Engrg.

CHEMIST, superintendent, age 30, married and employed, wishes to change for good reasons; experienced particularly in the manufacture of soap and glycerine and in the refining of vegetable oils; salary not under $4,000. PW-784, Chem. & Met. Engrg., Leader-News Bldg., Cleveland.

CHEMIST and metallurgist experienced in a wide field; for many years chief chemist for a large iron company, desires a position as chemist or superintendent in metallurgy or chemical manufacture. PW-787, Chem. & Met. Engrg.

POSITIONS WANTED

CHEMIST, college graduate, age 23, single; now employed; two years' excellent experience in analytical work, wishes to locate in southern California. PW-781, Chem. & Met.

CHEMIST, 24, university graduate with one year of post-graduate work, desires permanent position; some commercial experience; would consider work not purely chemical. Address Box 768, Yale Station, New Haven, Conn.

CHEMIST, assayer and executive assistant, desires only responsible position. Louis Bernabo, Ft. Dodge, Iowa.

CHEMIST-SUPERINTENDENT — Young man, assistant superintendent large factory, eight years' experience in acids, heavy chemicals, and electro-metallurgy, desires position as superintendent or assistant in chemical plant. Will consider position as chief chemist or in research. With present company four years, two years in present capacity, two as chief chemist. Good reasons for desiring change. Am married, age 29. PW-647, Chem. & Met., Real Estate Trust Bldg., Philadelphia.

CONSULTING chemical engineer, Ph.D., experienced in developing, construction and operating plants for the manufacture of acids, alkalis, glue, gelatin, oil and grease extraction, organic products, utilization of waste products, desires connection with firm who require a manager, technical executive, construction engineer or research chemist, with commercial judgment and capable of getting results. PW-786, Chem. & Met. Engrg., Leader-News Bldg., Cleveland.

EXECUTIVE, general superintendent, exceptional experience, management, engineering and construction; chemical and industrial plants; available June 25. PW-774, Chem. & Met.

FOUNDRY chemist, seven years' experience in foundry as helper, molder, coremaking, cupalo, machine, clerical and chemical work; one year as assistant in government laboratory; 18 months analytical and control work in iron and steel laboratory; prefer city 50,000 to 200,000; good conditions and vicinity. PW-782, Chem. & Met., Old Colony Bldg., Chicago.

INVESTIGATION chemist desires to get in touch with a concern requiring a trained chemist or electro-chemist, one to three days per week, to exploit or perfect formulae or process. Location within 100 miles of New York City, or in own laboratory. PW-785, Chem. & Met. Engrg.

METALLLURGIST and chemist; eight years' practical and executive experience in the custom smelting of copper, lead, leady-copper ores and mattes, and refinery byproducts; technical graduate; age 30; single. PW-790, Chem. & Met. Engrg.

METALLURGICAL chemist, married, 14 years practical experience, 4 years chief chemist and engineer of tests, desires similar position; Middle West. PW-775, Chem. & Met., Old Colony Bldg., Chicago.

POSITIONS WANTED

SUPERINTENDENT or executive position; age 33; college graduate; eight years' experience handling men, four years superintendent and manager inorganic chemical plants; specialties, continuous operation of equipment and production. PW-776, Chem. & Met.

WORK WANTED

LANTERN slides and photographic copies (4" x 5") made from drawings, blue prints, photographs, half-tones, etc. M. Slavin, 1220 Kings Highway, Brooklyn.

WANTED

Chemical Magazines Wanted and For Sale

Chemical & Metallurgical Engineering, the American Chemical Society publications, London Journal, others domestic and foreign. B. Login & Son, 152 East 23rd Street, New York, N. Y.

Abbis Refractometer Wanted

Must be in first-class condition. Portsmouth Cotton Oil Refining Corp., Portsmouth, Va.

FOR SALE

Commercial Laboratory For Sale

Commercial laboratory in growing industrial and mining city for sale or rent. FS-792, Chem. & Met. Engrg., Leader-News Bldg., Cleveland.

FOR SALE

CHEMICAL PLANT

Fully equipped plant suitable for manufacture of heavy chemicals or metals can be adapted to the requirements of foundry practice for small castings. Originally designed for lixiviating process for extraction of rare metal compounds and for reduction of pure metals. Premises include thoroughly up-to-date Chemical Laboratory and equipment for manufacture of pure chemicals. Very advantageously located to labor and railroad facilities, with available electric power, gas and water. Plant formerly operated by the Primos Chemical Company at Primos, Delaware County, Penna., eight miles from Broad Street Station, Philadelphia, on the Philadelphia, Baltimore and Washington Dvision of the Pennsylvania Railroad. For further particulars write or have representative call

Vanadium Corporation of America

Primos, Delaware Co., Penna.

FOR SALE

CHEMICAL PLANT

equipped with ball mills, number of tanks with agitators, both steel and wood, filter press, and box filter vacuum pump, steam boiler, and reverberatory furnace, suitable for manufacturing many inorganic or organic products. Within twenty miles of New York City; good transportation facilities by rail, boat or truck; plant now in operation; available after July first.

Apply B.O.769—Chem. & Met.
36th St. at 10th Ave., New York City

Wanted for Immediate Delivery

1—Oil Burning Locomotive, about 20 tons weight.
2—Locomotive Cranes, 8 wheels, 15 tons capacity each, 40-ft. beam, preferably Browning & McMyler.
6—Flat Cars, equipped with hand brake, about 15 tons each.

All for standard gauge track complete and ready to operate.

RICHARD AIREY, 94 FULTON ST., NEW YORK CITY

WE BUY

PLATINUM

In Any Form
At Market Values

CHECEL JEWELRY CO.
612 Euclid Ave., Cleveland, Ohio

WANTED

SCRAP PLATINUM

We will pay highest price. Small amounts especially solicited. Send in what you have. We will forward cash in return.

PAUL G. NIEHOFF & CO., INC.
Metallurgical Laboratories
232-242 East Ohio St., Chicago, Ill.

WANTED

2—Reducer Kettles, 800 and 1600 gals.
4—Sulphonators, 400 to 900 gals.
4—Nitrators, 400 to 900 gals.
2—Sweetland and 3—Plate and Frame Filter-Presses, 24 in. or 30 in.

Reply, giving lowest price and location in first letter.

W555—Chem. & Met. Engineering, 10th Ave. at 36th St., New York City.

WE WANT YOUR PLATINUM SCRAP

IN ANY FORM

We pay highest market price, make prompt returns and hold goods for your approval. Pure Gold, Silver and Platinum always on hand. Industrial Diamonds and Precious Stones bought.

I. MILLER, *Smelter and Refiner*, 252 Colonial Arcade, Cleveland, Ohio

Electric Furnace Ferro-Alloys Plant

with Crushing and Sizing Equipment, just as it was operated and is practically new, having only been operated about one year. Will sell as a whole or machinery in plant.

FRANK M. GORSUCH, 522 LIGHT ST., BALTIMORE, MD.

WANTED

Petrographical Microscope

Must be in first-class condition and fully equipped with the necessary accessories. Kindly address reply to the Research Division.

NEW JERSEY ZINC COMPANY
Palmerton, Pa.
Attention: Frank G. Breyer.

Cash for Your Platinum

Ship to us by mail or express, any large or small amounts of platinum. We buy new or broken platinum crucibles, covers, dishes, wire, contact points, etc. We also buy solutions containing the precious metals. We buy gold or silver in any shape or form, also mercury or palladium. Residues containing the precious metals refined and purchased. Send now. Cash is sent same day goods received, by registered mail. Bank references and satisfied customers all over the world. Nothing too large or too small, everyone welcome to ship to us. Highest prices assured.

THE OHIO SMELTING AND REFINING COMPANY
291 Lennox Bldg., Cleveland, Ohio, U. S. A.

FOR EVERY BUSINESS WANT

"Think SEARCHLIGHT *First"*

0109

SHARPLES CENTRIFUGAL CLARIFIERS

Nine No. 6 turbine driven Sharples Centrifugal Clarifiers, complete with extra bowls and all accessories, for immediate delivery from Chicago. These have been used only a few hours and are in perfect condition. At a sacrifice.

WILLIAM D. NEUBERG
CHEMICAL ENGINEER **LYTTON BLDG., CHICAGO, ILL.**

FOR SALE

4—Agitator Steel **Tanks**, 2,000, 3,000 gal.
1—400 gal. Direct Fire Still with vacuum pump.
1—225 gal. Nitrator.
2—50-gal. Copper Stills.
8—Centrifugals, 16-in., 30-in., 40-in., 48-in.
3—Oliver Filters, 6-ft. x 6-ft., 8 ft. x 6-ft., 12-ft. x 8-ft.
1—No. 30, No. 150 Kelly Copper Filters.
1—No. 9 Sweetland Filter.
1—30-in. x 30-in. Sperry Filter Press.
1—28-in. Smith Vaile Filter Press.
1—5-ft. x 25-ft. Rotary Vacuum Dryer.
1—No. 28 Va. Shelf Dryer, Devine.
1—3-ft. x 25-ft. Rotary Vacuum Dryer.
1—No. 11 Devine Shelf Dryer.
4—100-gal. Jacketed Kettles.
1—200-gal. Jacketed Kettle.
4—4 x 10-ft. Drum Dryers.
10—5,000 to 12,000 Steel Storage Tanks.
1—11,000-gal. heavy storage tank.

Let us have your inquiries *Tanks—Stills—Kettles—Nitrators*

CONSOLIDATED PRODUCTS COMPANY, INC.
38 Park Row, New York
Warehouse: West Side Ave. Station, Jersey City, N. J. **Telephone: Cortland 7506-7**

FOR SALE

24 Open Top **Steel Tanks**, 7-ft. 3-in. diam., 4-ft. 6-in. deep, of 7/16-in. plate.
10—Steel Frame **Flat Cars**, 36-in. gauge, roller bearings.
210 pcs., 1-in. **Duriron Pipe** in 3-ft. lengths with plain ends.
143 **Duriron Elbows** 1-in. with plain ends.
62 pcs. 1-in. **Duriron Pipe**, 8-in. long, flanged at one end.
Duriron U Bends, Goose Necks, steam jets.
50—**Duriron Agitators** 3-ft. wide, 5-ft. long 8 arms.
1585 Grade "R" Filtros **Plates**, 12 x 12 x 1½-in.
168 Pcs. **Slate** 24 x 28 x 1½-in.
2—Sullivan, steam driven, single stage, straight line **Air Compressors** Class WA-5, 345 cu.ft. capacity, 120-lb. air pressure.

All the above new and in original crates, delivery Rouse's Point, N. Y.

Write to the St. John Dry Dock and Shipbuilding Co., Ltd., Drummondville, Quebec, for all particulars.

St. John Dry Dock and Shipbuilding Company, Ltd.
Drummondville, P.Q.

Rotary Dryers For Sale

3 Rotary Dryers, 4-ft. diameter, 30-ft. long, gear driven, complete with furnace irons.

McDERMOTT BROS. CO.
Allentown, Pa.

MACHINERY BARGAINS

Our warehouses are stocked with 1,000 Boilers, Engines, Pumps, Generators, Machine Tools and other machines, for prompt shipment; rebuilt and guaranteed.

WICKES MACHINERY COMPANY,
Jersey City, N. J.

CHEMICAL EQUIPMENT

of every description always on hand

CONTINENTAL MACHINERY CO.
50 Church Street, New York City

CENTRIFUGALS

FOR SALE

18—40-in. Steel Basket, Tolhurst Centrifugal Extractors; Suspended Type.
6—40-in. Tolhurst Extractors; Self Balancing Type; B. D.
4—36-in. Tolhurst Extractors; NEW.
5—40-in. Oil and Waste Saving Machine Co. EXTRACTORS.
4—24-in. Extractors.

Machinery & Equipment Co., Inc.
225-231 Sherman Ave., Newark, N. J.

APPARATUS FOR SALE

2—5 gal. Mixing Auto-Claves.
4—35 gal. Jacketed Day Mixers.
2—50 gal. Jacketed Day Mixers.
3—50 gal. Galvanized Day Mixers.
3—175 gal. Jacketed Sulphonators or Mixing Kettles with covers.
4—225 gal. C. I. Jacketed Kettles.
1—250 gal. Rapid Dissolver Mixing Kettle, Werner & Pfleiderer make.
2—300 gal. Jacketed Dopp Kettles, with double agitators.
1—24 in. sq. C. I. Shriver Press.
7—30 in. sq. Shriver Filter Presses.
5—Westinghouse Air Compressors, 8 x 8 x 10, and 9½ x 13 x 10.
1—25 hp. Horizontal Nagle Steam Engine.
4—30 hp. Westinghouse Steam Engines.
5—200 gal. Galvanized Tanks; new.
16—450 gal. Steel Tanks, 5 x 4 x 3 ft. deep, with covers.
2—900 gal. Jacketed Kettles, 5 ft. dia. x 6 ft.
6—Evaporating Tanks, 6 ft. 6 in. x 16 ft. x 24 ft. deep. Full Jacketed.
2—Blackmer Rotary Pumps.
2—Root Blowers, Size No. 1.
1—Lead-lined Blow-case, 3 ft. dia. x 5 ft.

MACHINERY & EQUIPMENT COMPANY
225-231 Sherman Ave., Newark, N. J.

IMMEDIATE DELIVERY

BOILERS

4—78-in. x 18-ft. A. S. M. E. Return tubular Boilers, quadruple butt-strapped riveted, 175-hp. each.
6—72-in. x 18-ft. A. S. M. E. Return Tubular Boilers, triple butt-strapped riveted, 150-hp.

FEED WATER HEATER

STACKS

2—90-ft. x 48-in., ⅛-in. plate.
1—80-ft. x 42-in. ¼-in. plate.

PUMP

1—Deane of Holyoke 16-in. x 10¼-in. x 18-in. Tank Service Pump.

DERRICK

1—Complete Coal or Stone Unloading Derrick, consisting of latticed steel mast and boom, 1¼-yd. clamshell bucket, 10 x 12 D.D., D.C. Haiss high-speed engine.

The above equipment may be inspected at 450 Greenpoint Ave., Brooklyn, N. Y.

RELAYING RAILS

35 tons 65-lb. A. S. C. E. Relaying Rails.
Approximately 700 tons original 48-lb. Relaying Rails with Angle Bars. Immediate delivery.
A large tonnage of Rails for Structural and concrete reinforcing purposes.

Complete with bars to match

M. C. FAIRCHILD & CO., Inc.
347 Madison Ave., New York City

CHEMICAL EQUIPMENT

2—Phenol Stills, 44-in. diameter x 4-ft. 2-in. deep.
1—Jacketed Vacuum Still, 6-ft. 6-in. diameter x 6-ft. deep, with agitator.
2—Cast Iron Kettles, 25-in. diameter x 36-in. deep.
6—Steel Jacketed Plates.
2—Quenching or Dissolving Kettles, 6-ft. 6-in. diameter x 6-ft. 6-in. deep.
1—Fusion Kettle (with agitator) equipped with oil burners.
1—Rotary Dryer, 4-ft. 3-in. diameter x 19-ft. long, made by J. P. Devine of Buffalo, N. Y.
1—New Rectifying Column or Benzol Still, 32-in. x 26-ft. 8-in. long (with still 6-ft. 6-in. deep x 8-ft. 2-in. diameter).

HEATERS

1—1300-hp. Blake Heater.
1—1500-hp. Berryman Heater.
1—200-hp. Reilly Multicoil Heater.
1—1000-hp. Wheeler Condenser.

TANKS

Lot of Open and Closed Steel Tanks.
All sizes of tanks, open and closed, suitable for storage of gasoline or fuel oil, in stock at our Boston yard.

BOILERS

2—Erie City Water Tube Boilers, 400-hp. each.
1—Mass. Standard 72-in. H. R. T. Boiler.
Also Vertical Types in Stock.

CABLEWAY EQUIPMENT

16—7 x 10 double drum Stroudsburg Engines, fitted with link motion; drums 24-in. x 24-in., with rear one having concave ends for transversing line.
125,000 ft. of ⅝-in., 1⅜-in. and 1¼-in. Wire Cable.

The Perry, Buxton, Doane Co.
214 West First St., South Boston, Mass.

EQUIPMENT FOR SALE

THREE TANKS

with Agitators and Strainers; each tank 12-ft. x 3-ft. 6-in. x 3-ft. 10-in. deep; also steam jacketed copper and cast iron Kettles of various sizes; Centrifugals of various sizes; Boilers, Engines and Machinery of all kinds.

INTERSTATE MACHINERY CO.,
Troy, N. Y.

MIXERS

We specialize in new and used Kneading and Mixing Machines and are in a position to recommend the

Right Machine for Your Purpose

CENTRAL EQUIPMENT CO.
1036 Detroit Savings Bank Bldg., Detroit, Mich.

A Big Snap for Quick Sale

At Curtis Bay, Baltimore, Md., we offer, in order to move quickly, the following items at bargain prices:

250 Carloads Beechwood Shavings in perfect condition. Used for generating vinegar.

40—60,000 gal. Tank, 25 ft. x 18 ft. deep; made of Oregon Fir, with 2½-in. Staves. Bottoms 3 in. thick, sectional covers.

Condition A1. Practically New. All staves numbered for reassembly.

200—All Brass—Chemical Proof Globe and Gate Valves; sizes from 6 in. down to ¾ in. Mostly 6, 5 and 3-in. sizes. All are standard makes, such as Fairbanks, Chapman, Jenkins, Crane, etc.

70,000 feet 10 in. x 10 in. Georgia Long Leaf Pine Timbers in 30 ft. and 40 ft. lengths.

20,000 feet 8 in. x 10 in. Georgia Long Leaf Pine Timbers in 12 ft. and 14 ft. lengths.

The above timber is all "heart" wood, in A1 condition.

100 tons Bolts and 80 tons O.G. Washers, sizes of bolts 1 in. x 7 to ¾ in. x 15 in.; Washers, 1 in. and ¾ in.

The above material is ready for immediate delivery subject to prior sale. Will be disposed of in lot or separately. Write for prices and particulars.

Priced far below value—quick action is recommended.

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PRODUCTOGRAPH

—AT A BARGAIN

Will keep count and curve drawing sheet record on 20 producing machines. Operates on 20-v. D.C. service.

Original cost $600. First-class shape. Various spare parts included.

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One Riehle Improved

Oil Testing Machine

10,000 lb. capacity. Also one white Souther Endurance Testing Machine. Good condition. Dept. 206.

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FOR SALE

GAS SUPPLY OUTFIT

for Laboratory Blaugas System

Chipman Chemical Engineering Co., Inc.
95 Liberty Street, New York

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ONE KELLEY FILTER PRESS

Type 150 with extra set of press frames.

ONE BUFFALO CRYSTALLIZER

Steam jacketed, 300 gallon capacity.

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Ashland, Mass.

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From Camp Stuart, Newport News, Va. Practically new. Used for storing hot water. Made of black sheet iron. Sheets ¼-in. thick and heads 5/16-in. thick. Double riveted and tested to 200 lb.

250—5 ft. x 24 in., 120 gal. capacity. 250—5 ft. x 36 in., 210 gal. capacity.
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250—6 ft. x 48 in., 525 gal. capacity.

Send for complete list of building and electrical material and power plant equipment.

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STEAM ENGINES

1—16 in. x 18 in. Erie City, 125 hp. at 150 r.p.m. and 100 lb. steam pressure, with rope drive, complete, like new.

1—18 in. x 22 in. Erie City, 180 hp. at 135 r.p.m. and 100 lb. steam pressure, with rope drive, complete.

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NEVER TAKEN OFF THEIR SKIDS

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4 CONNERSVILLE GAS BLOWERS

(Boston Type 502 Gas Pumps)

Displacement 19.8 cu. ft. per revolution. Weight 12,700 lbs.
Speed 260-300 R.P.M Floor space 40 x 114 inches.

IMMEDIATE SHIPMENT **THE IRON PRODUCTS CORP.** ***WIRE or WRITE***
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EVAPORATOR

48-in. inside diameter by 8-ft. 6-in. high complete with wet vacuum pump.

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"Opportunity" Advertising:

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Chemical Process Machinery

IMMEDIATE SHIPMENT

Condition Guaranteed

We have purchased all surplus Werner & Pfleiderer Mixers of the Hercules Powder Company. At our price, they are an attractive purchase. We advise quick action, as there are only three left. These mixers were used in the manufacture of Nitro-Cellulose and are in first-class condition.

Specification—Werner & Pfleiderer Universal Mixers, type VI, size 15, class B.B., 100 gal. working capacity. Cast-iron trough, jacketed. Hinged cover. Double mixing blades, geared both ends. Screw tilting device.

FILTERS AND FILTER PRESSES

1—Sweetland Filter, size No. 10, 31-in. inside dia., 109-in. inside length, equipped with 43 leaves, spaced 2½-in. center to center. Containing 434 sq.ft. filtering area.
1—Sweetland Filter, size No. 2, 16-in. inside dia., 36½-in. inside length, equipped with 23 leaves, spaced 1½-in. center to center. Containing 60 sq.ft. filtering area.
1—Oliver Continuous Rotary Filter, drum 4-ft. dia., 6-ft. wide, containing 75 sq.ft. filtering area. Complete with vacuum system.
1—Oliver Continuous Rotary Filter, drum 3-ft. dia., 4-ft. wide, containing 36 sq.ft. filtering area. Complete with vacuum system.
1—Iron Filter Press, 24-in. square, 27 chambers, 1-in. cake. Cast-iron plate and frames. Corner feed, two-eyed, closed delivery, non-washing. Equipped with 11 plates 1¼-in. thick, and 17 plates 2⅝-in. thick, hollow for steam heating.
1—Iron Filter Press, 18-in. square, 20 chambers, 1-in. cake. Cast-iron plate and frame. Corner feed, four-eyed, closed delivery, washing type.
4—Suction Filter Tanks, 300 gals. capacity, ¼-in. steel plate. Fitted with perforated false bottom. Open top.

CENTRIFUGALS

1—Broadbent (English) Centrifugal Machine, 48-in. dia. steel basket, 14-in. deep. Center-slung type, open top, top discharge. Under-driven, no countershaft. Including cast-iron casing, two idler pulleys, large brake band acting directly on basket, cast-iron bed plate, three pedestals for supporting casing.
18—Tolhurst Centrifugal Extractors, 40-in. steel basket, annular bottom discharge, automatic unloader. Suspended type, overhead belt-driven. Complete without steel supports or countershaft.
3—Tolhurst Centrifugal Extractors, 40-in. steel basket, bottom discharge. Self-balancing type, belt-driven, no countershaft.
1—American Laundry Centrifugal, 26-in. copper basket, under-driven, top discharge.

VACUUM CHAMBER DRYERS

1—Devine, size No. 28, double door, 20 shelves, 59-in. x 78-in., 2⅜-in. spacing. Including steam-driven vacuum pump and vertical tube Condenser. 1300 sq.ft. heating surface.
1—Devine, size No. 27, double door, 17 shelves, 59-in. x 78-in., 2⅞-in. spacing, 1105 sq.ft. heating surface.
1—Devine, size No. 23, double door, 13 shelves, 59-in. x 78-in., 2⅞-in. spacing, 845 sq.ft. heating surface.
2—Devine, size No. 11, single door, 17 shelves, 40-in. x 43-in., 2⅞-in. spacing, 432 sq.ft. heating surface.

ROTARY VACUUM DRYERS

1—Devine, 5-ft. dia., 33-ft. long, complete with injection Condenser, Separator, Steam-driven Vacuum Pump 8 x 12 x 12.
1—Devine, 5-ft. dia., 30-ft. long, motor-driven, complete with tubular surface condenser, motor-driven dry vacuum pump.
1—Devine, 42-in. dia., 25-in. long, with condenser.
1—Buffalo, size R-4, 3-ft. dia., 15-ft. long, complete with dust collector, tubular surface condenser, belt-driven dry vacuum pump. Including Cooler 3-ft. dia. 15-ft. long.

DRUM DRYERS

1—Devine Vacuum Drum Dryer, 42-in. dia., 10-ft. long. Complete with two jacketed Receivers, Dust Filter, Barometric Condenser, belt-driven dry vacuum pump.
1—Perrin Atmospheric Drum Dryer, 4-ft. dia., 8-ft. long.

ROTARY DRYER

1—Louisville Steam Tubular Rotary Dryer, 6-ft. dia., 20-ft. long, containing 35 tubes 4½-in. dia.

PROCESS MACHINERY

1—Devine Single Effect Evaporator, 6-ft dia., 17-ft. high, containing 500 iron tubes 2-in. dia., 4-ft. long. Complete with Salt Filter, Barometric Condenser, no vacuum pump.
1—Buffalo Foundry 800 gal. Nitrator, 5-ft. dia., 6-ft. deep, single propeller type agitator, bevel gear drive, pulleys, and steel plate cooling jacket.
1—Sulphonator, 375 gals. capacity, 54-in. dia., 52-in. deep. Cast-iron, round bottom steam-jacketed. Dished cover with manhole, seven flanged pipe connections. "U" shaped cast-iron agitator, bevel gear drive, pulleys.
6—Cast-iron Kettles, 350 gals. capacity, 56-in. dia., 46-in. deep. Round bottom, open top. Heavy "U" shaped cast-iron stirrer, bevel gear drive, tight and loose pulleys, bearings, supported on two 8-in. I-beams. Can be used for any alkaline fusion process or for melting heavy material, using direct fire.
1—Valley Iron Autoclave, 100 gals. capacity, 2-in. cast-iron, fitted with agitator, bevel gear drive, 20-in. pulley. Manhole and five openings in cover, also bottom outlet.
1—Valley Iron Autoclave, 10 gals. capacity, built for 900 lbs. pressure, 12-in. dia., 24-in. deep, 2-in. walls, full jacketed, bolted-on cover.
1—Copper Still, 1200 gals. capacity, 6-ft. 4-in. dia., 5-ft. length of shell, dished top and bottom. Fitted with flat steam coils containing 7 loops 1⅝-in. copper pipe; 2½-in. and 1½-in. bottom outlets. Manhole in shell and 24-in. vapor connection on cover.
1—Devine Vertical Tube Preheater, steel shell 27-in. dia., 8-ft. long, fitted with 80 wrought iron tubes ¾-in. dia., 87-in. long. Arranged with quick opening and closing hinged doors on each end and fitted with steam and liquor inlets and outlets.
1—Bartlett Steam Dryer, 6-ft. dia., 25-in. deep, full jacketed on side. Side bottom discharge door. Heavy agitator, bevel gear drive, pulleys.
1—Steam-Jacketed Pan, 1000 gals. full capacity, 8-ft. dia., 30-in. high at side, 42-in. deep at center. Open top, dished bottom with 3-in. bottom outlet. Shell ⅜-in. plate. Jacket ⅛-in. plate, thoroughly stay-bolted. Supported on four cast-iron legs, 4-ft. high overall.
4—Mitts and Merrill No. 22 Hogs, equipped with six 15-in. rotary knives.
2—Laidlaw-Dunn-Gordon Air Compressors, duplex single stage, size 10-in. x 12-in., capacity 565 cu.ft. free air per minute at 260 r.p.m. Equipped with feather valves. Complete, with or without 75 hp. Motors and idler pulley for close drive.
1—Devine Dry Vacuum Pump, 4-in. x 6-in., belt-driven, single stage.
1—Knowles Duplex Steam Pump, size 12 x 7 x 10. Equipped with discharge air chamber, water-end fitted with hand rubber disc valves, brass valve seats, and brass cylinder lining.
2—Worthington Pot Valve Pressure Pumps, 6 x 3½ x 6, duplex steam-driven, 300 lbs. working pressure, 65 gals. per minute.
4—Day Jacketed Mixers, half-barrel capacity. Equipped with hinged cover, ribbon agitator, bottom discharge gate, without pulleys. Inside measurements 13-in. x 40-in. x 15-in. deep. Galvanized steel. New.
1—Vertical Tube Steel Condenser, 30-in. dia., 7-ft. long, containing 128 steel tubes 1¼-in. x 6-ft.
1—Badger Vertical Tube Copper Condenser, 16-in. dia., 7-ft. long, containing 47 copper tubes.

COMPARTMENT DRYERS

1—Gordon type "D" Dryer, single compartment, 504 sq.ft. drying surface, capacity 84 trays 25-in. x 38-in., complete with blower.
1—Steiner Gas Heated Drying Oven, three-compartments, capacity 30 trays, 20 x 30-in., 1½-in. deep.

MILLS

1—Smidth Tube Pebble Mill, 4-ft. dia., 16-ft. long, brick-lined. Trunion bearings, spur gear drive, countershaft with clutch and drive pulley. Automatic feed. Screen discharge. Full charge flint pebbles.
1—West Tube Pebble Mill, 44-in. dia., 21-ft. long, silex lined. Trunion bearings, spur gear drive, countershaft. Automatic feed.
1—Abbe' Pebble Mill, size No. 6, cylinder 30-in. dia., 33-in. long, porcelain-lined. Complete with legs, tight and loose pulleys.
1—Patterson Pebble Mill, cylinder 36-in. dia., 48-ft. long, brick-lined, gear-driven. Complete with legs and countershaft.
1—Sturtevant Balanced Crushing Rolls, 16-in. x 10-in., two-drive pulleys, 48-in. dia., 4-in. face.

TANKS

27—Rectangular Steel Tanks, 750 gals. approximately 5-ft. x 8-ft., 30-in. deep, ⅛-in. plate. Flat bottom, tapered sides, open top.

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2—**200-gal. General Ceramics** Armored Montejus.
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3—**Tolhurst Centrifugals,** 48-in. copper baskets, over-driven.
3—**Fuller-Lehigh 42-in. Pulverizing Mills.**
1—**80-gal. Copper Kettle,** jacketed, cover, no agitator.
2—**Buffalo Fusion Pots,** 30-in. dia., 48-in. deep. Heavy stirring apparatus.
1—**Ruggles-Coles Type W-10 Rotary Dryer,** complete with steam pipe, blower, driving mechanism.
1—**Steiner Gas Heated Drying Oven,** with trays, burners, thermostat, etc.
1—**Hardinge Conical Mill,** 36-in. dia., no lining, iron balls.
3—**Pratt Acid Eggs,** "Type A," capacity 75.8 cu. ft.
1—**1-gal. Laboratory Autoclave,** 800 pounds, jacketed, agitator.
1—**1-gal. Laboratory Autoclave,** 800 pounds, no jacket, agitator.

USED EQUIPMENT

6—**Buffalo Crystallizers,** 72-in. dia., 18-in. deep, jacketed.
1—**Devine Rotary Vacuum Dryer,** 5-ft. x 30-ft., complete unit.
1—**Buffalo Rotary Vacuum Dryer,** 3-ft. x 15-ft., complete unit.
2—**C. I. Vacuum Pans,** 9-ft. dia., copper coils, condenser.
5—**Stokes Mixers,** 400 gals. gross capacity, C. I. trough, jacketed. Tilting.
3—**Werner & Pfleiderer Mixers,** Type VII, Size 18, 290 gals. working capacity.
2—**300-gal. Sulphonators,** cast-iron, jacketed, agitated, bottom discharge.
1—**Elyria Blue Enamel Dish,** 30-in. dia., 10-in. deep, jacketed.
1—**150-gal. Copper Still,** dephlegmator, condenser.
5—**Patterson "Regular" Agitators,** for tanks 4-ft. dia. and over.
1—**Tube or Ball Mill,** 48-in. dia. x 16-ft. long, continuous feed and discharge.
2—**Hardinge Conical Mills,** 36-in. dia., no lining, iron balls.
1—**Swenson Triple Effect Evaporator,** iron tubes.
2—**3,500-gal. Digestors,** jacketed, agitated, 150-lb. internal pressure, 150-lb. steam pressure.
1—**Kelly Filter No. 250**—eight leaves 4-in. centers.

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AUTOCLAVES—Two 120-gal. steel with stirrers. One 75-gal. jacketed one 100-gal. lead lined.
CENTRIFUGALS—60-in., 46-in., 44-in. iron basket; 48-in., 40-in. and 26-in copper basket.
COOKERS—5 x 16-ft. with stirrer and steam jacket.
CRYSTALLIZERS—One Buffalo 300-gal. crystallizer, steam jacketed.
DRYERS—**Direct-heat rotary dryers** 3 x 25-ft., 3½ x 25-ft., 4 x 30-ft., 5 x 35-ft., 5½ x 50-ft., 6 x 50-ft. and 7½ x 60-ft., double shell dryers; 4 x 20 ft., 5 x 30-ft. and 6 x 35-ft.
Steam-heated Air Rotary Dryers 4 x 30-ft., 6 x 30-ft.
Steam-Jacketed Dryers 4 x 18-ft. with stirrer.
Rotary Vacuum Dryers 4 x 15-ft., 3½ x 25-ft., 3 x 15-ft., 5 x 30-ft. and 2 x 4-ft.
Vacuum Shelf Dryers 4 shelves, 9 shelves, 17 shelves. 17 shelf (double doors).
EVAPORATORS—One triple effect with copper tubes. One single effect, iron tubes; one double effect and one triple effect, all copper; one double effect, basket type, iron tubes.
FILTER PRESSES—No. 150 and No. 250 Kelly's, No. 9 Sweetland, 3 x 4-ft. (acid proof) and 12 x 20-ft. rotary continuous filter (Oliver). Plate and frame presses of wood and iron.
HYDRAULIC PRESSES—500-ton, 350-ton, 200-ton, 100-ton and 75-ton hydraulic presses. Continuous fish presses.
KILNS—Rotary Kilns: 8 x 60-ft., 6 x 60-ft., 3½ x 25-ft. and 3 x 25-ft.
NITRATORS—2,400-gal., 1,600-gal., 500-gal., 350-gal. and 250-gal. nitrators.
MILLS—24-in., 22-in., and 20-in. Schutz-O'Neill Mills, 6 x 5-ft., 2½ x 3-ft., 3 x 3½-ft. pebble mills; 5 x 3½-ft., 6 x 6-ft., 5 x 4-ft., 4½ x 3½-ft. and 2½ x 2½-ft. ball mills; 3-ft. Marcy Mill; 33-in. and 24-in. Fuller-Lehigh Mills; 4½ x 20-ft., 5 x 11-ft., 5 x 22-ft. and 6 x 20-ft. Tube Mills; 20 x 13-in., 9 x 12-in., 7½ x 13-in. and 7 x 10-in. jaw crushers; one No. 00 and one No. 2 Williams' swing Hammer Mills; one Kent Type "G" Mill; one Aero pulverizer, type "D"; two 36-in. and one 42-in. cage Mills; one 8-ft., two 4½-ft. and two 3-ft. Hardinge Conical Mills; 18-in x 12-in., 20 x 12-in. and 30 x 10-in. roll crushers; No. 0, No. 1 and No. 3 Sturtevant rotary crushers; one No. 2 Sturtevant ring roll crusher; one 4-roll Raymond Mill; one No. 3 Talesmith breaker; one 36-in. Sturtevant emery Mill; one Griffin Mill; one 51-in. x 14-in. Chaser Mill.
MIXERS—One 1-ton acid phosphate Mixer; 1-ton batch Mixer; ten 100-gal. W. & P. heavy duty jacketed Mixers; 150-gal. dough Mixers.
SULPHONATORS—2,000-gal., 400-gal. and 350-gal.; 1,200-gal. Reducer.
STILLS—Copper Stills with dephlegmators, condensers and fractionating columns; 16 x 60-in. in diameter for solvent recovery or alcohol or ether manufacturing; 4½ x 3-ft. 6-in. copper vacuum Still; 500-gal. phenol Stills; 8 x 3-ft. beta naphthol Still.
VACUUM PUMPS—8 x 12 x 16-in.; 8 x 20 x 12-in.; 8 x 16 x 12-in.; 12 x 12-in.; 6 x 4-in.
SPECIALS—Emerick 8-ft. Separators; four 6 x 8-ft.; 6 x 6-ft. Kominuters; one McDougal and one Wedge Mechanical Furnaces; five automatic package Weighing Machines; Electric Arc Furnaces; Jigs; one Keystone Excavator; 6 x 8-ft.; 6 x 5-ft.; and 4 x 3-ft. Newaygo Vibrating Screens.
SULPHUR BURNERS—4 x 10-ft., 4 x 16-ft.; 4 x 20-ft.
RETORTS—Six Buflokast 3,100-gal. Nitric Acid Retorts.
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All this equipment is complete and in good condition

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1—Still, COPPER, 100 gal. capacity. Complete with condenser.
1—Still, ALUMINUM, 450 gal. capacity. Jacketed.
1—Jacketed still. Body of C. I. Goose-neck and Condenser COPPER. 500 gal. capacity.
1—Vacuum Milk Pan or Still, COPPER. Diameter 6 feet. And many others 35-gal. to 5000 gal. capacity.

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We also have numerous other Filter Presses, as well as Autoclaves, Centrifugals, Dryers, Evaporators, Filters, Kettles, Kilns, Mills, Mixers, Nitrators, Sulphonators, Reducers, Pulverizers, Pumps, Tanks.
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One roofing material manufacturer recently bought several mixers for experimental purposes. They found them so efficient in their industry that we have since received four repeat orders from this one concern.

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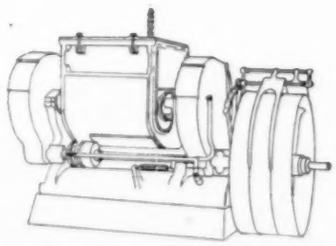

WERNER & PFLEIDERER

MIXERS

JK-NR2002. 20 new Werner & Pfleiderer mixers, size 15, type VI, class BB, working capacity 100 gal., total cap. 150 gal. Equipped with c. i. trough, jacketed, 33 x 38 x 31. C. I. hinged air-tight cover. With idler, forward and reverse pulleys, 48 in. diam., 7 in. face. Tenn.

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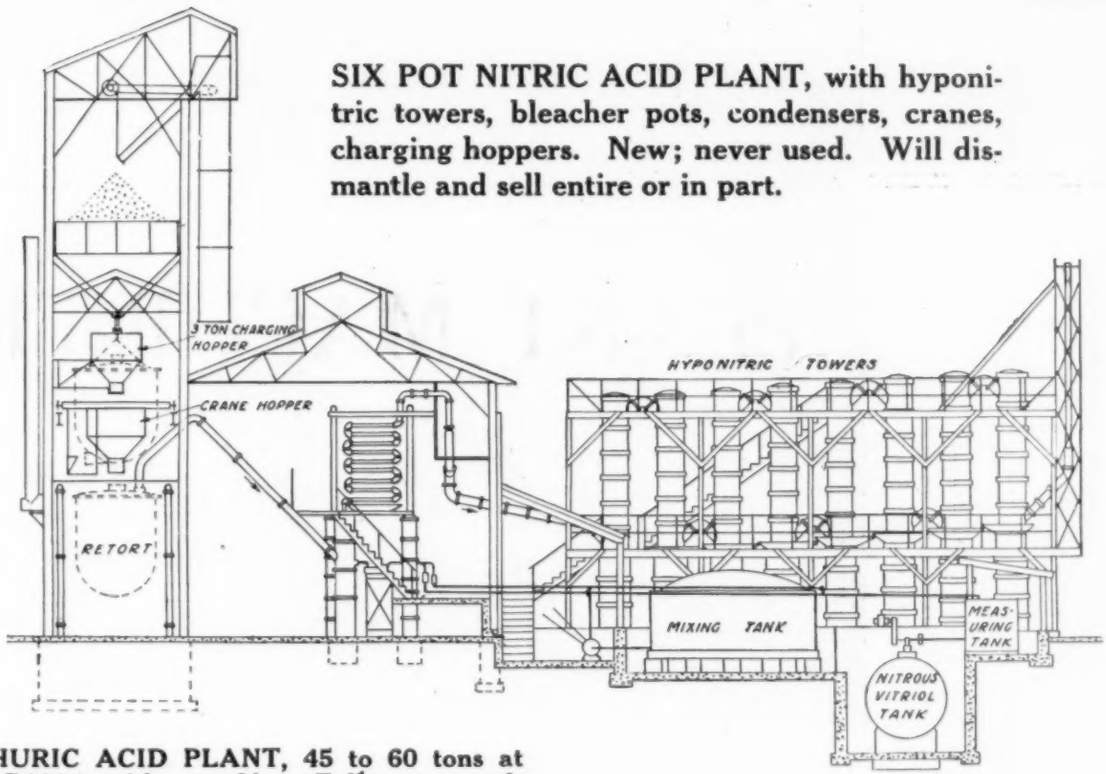

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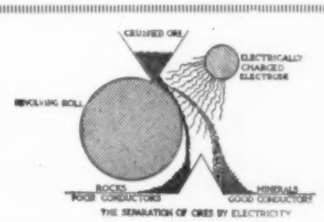

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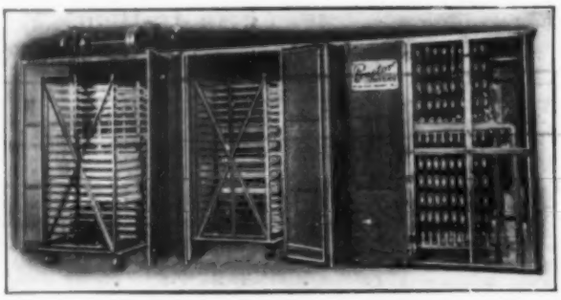

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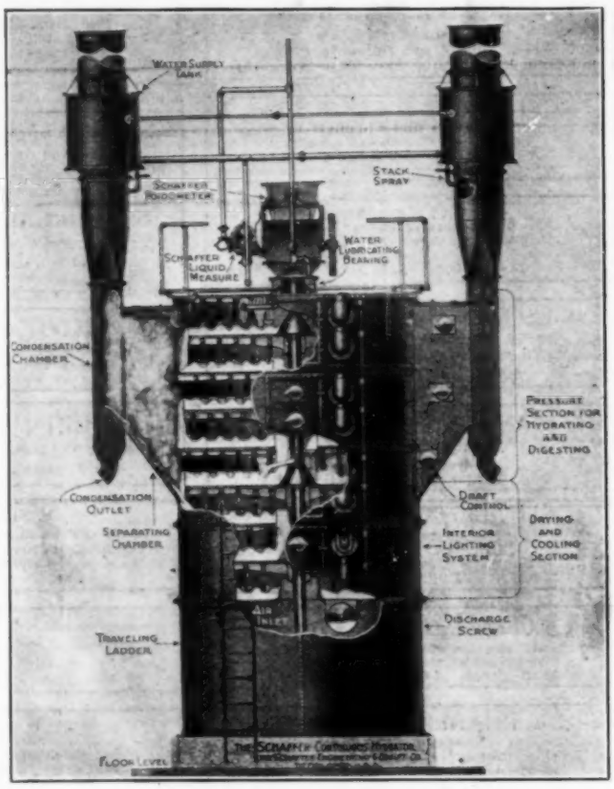

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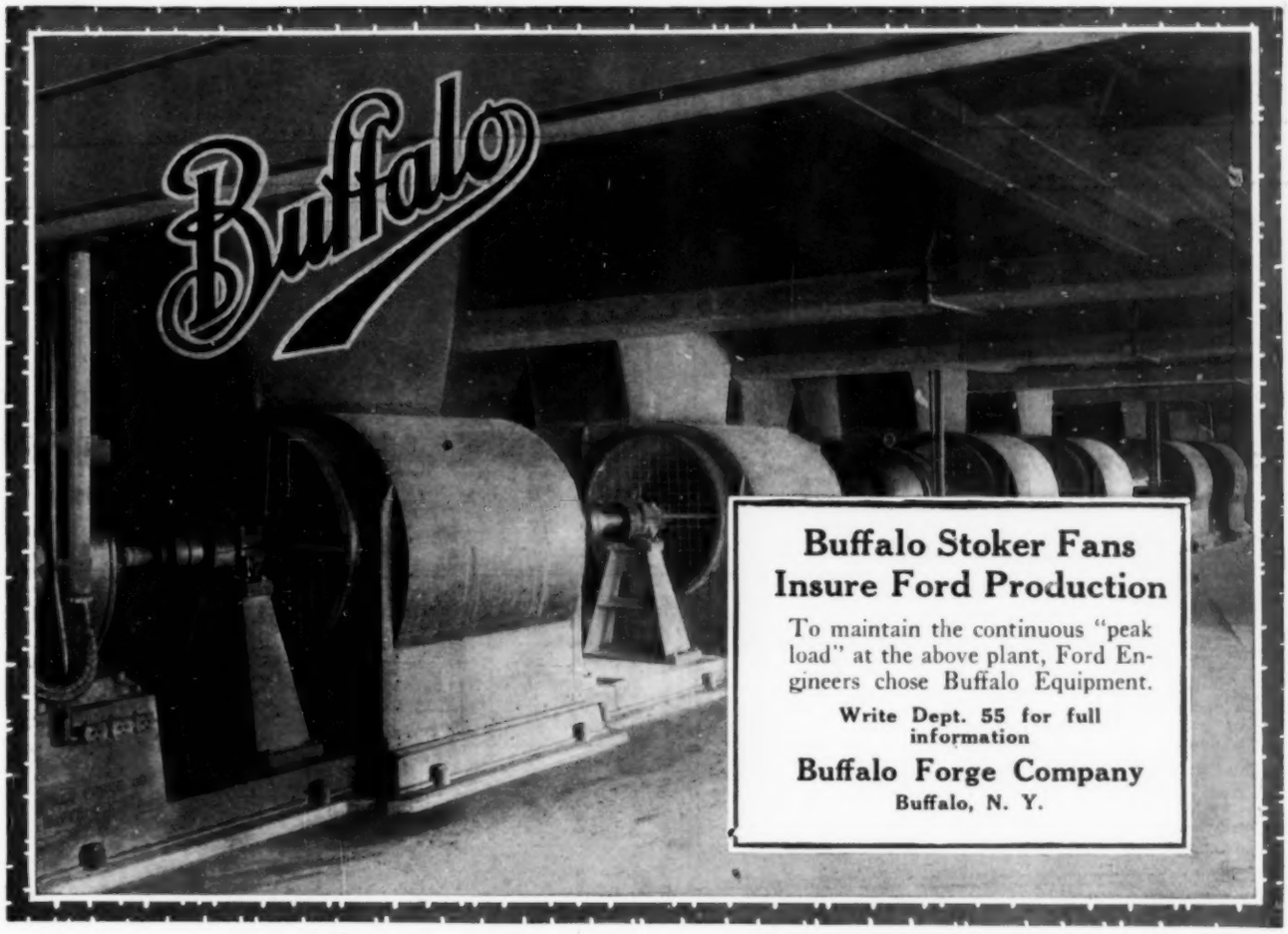

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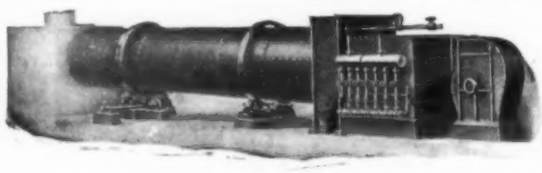

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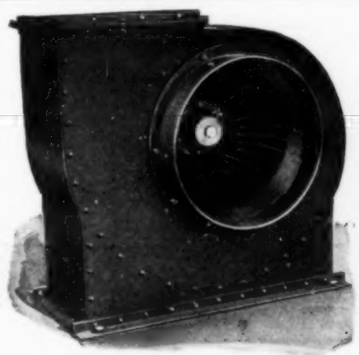

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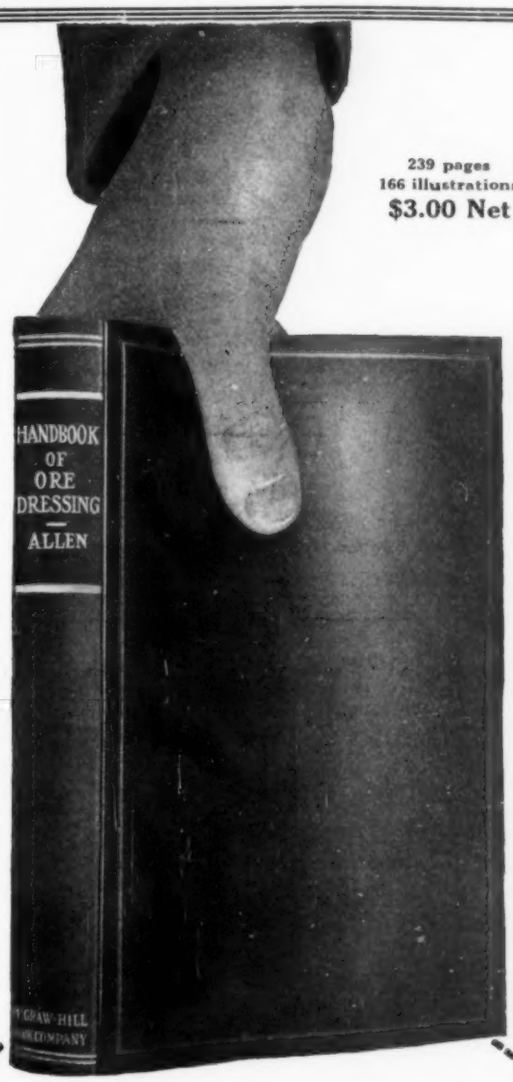

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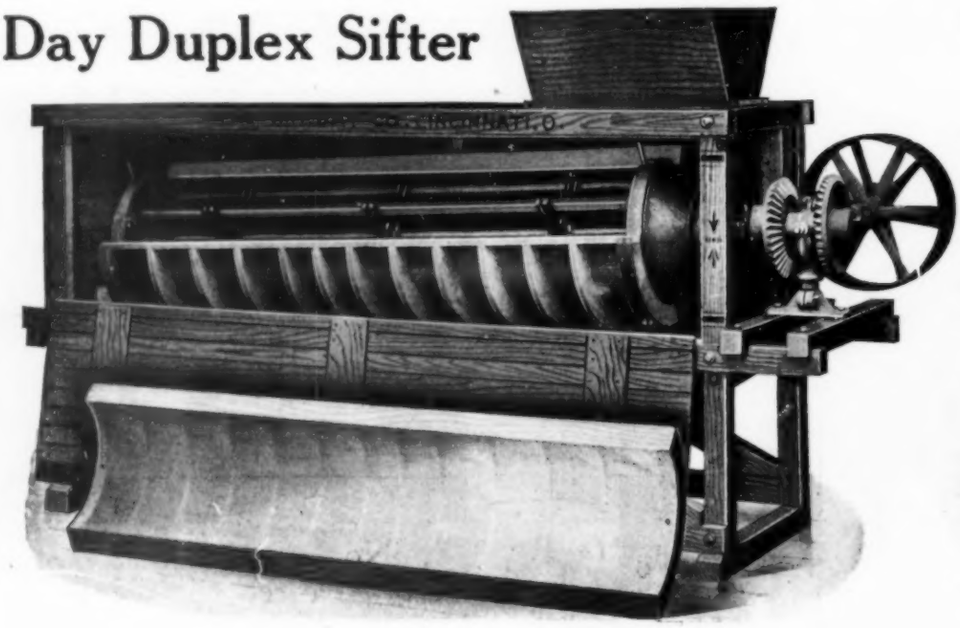

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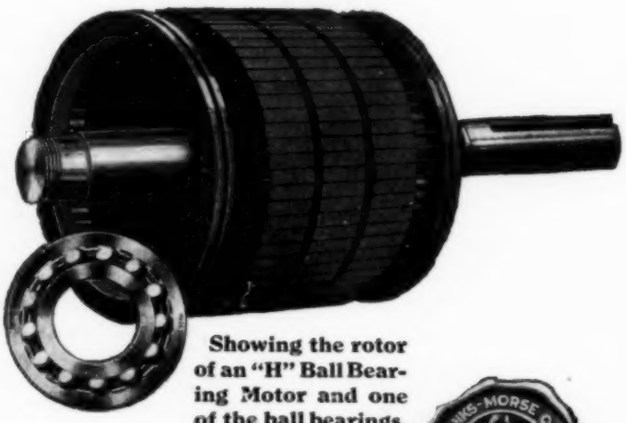

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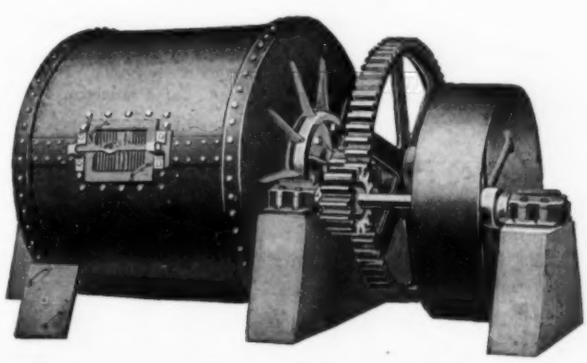

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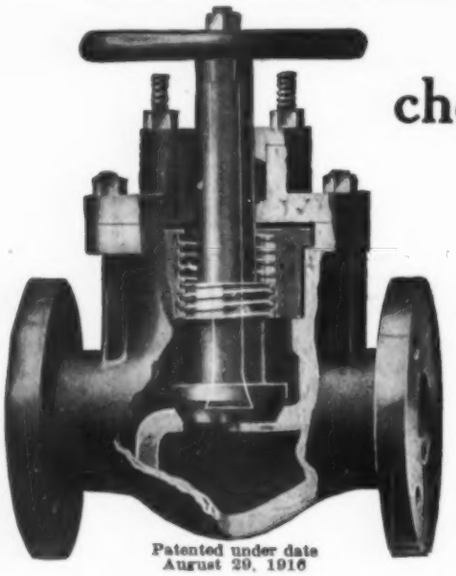

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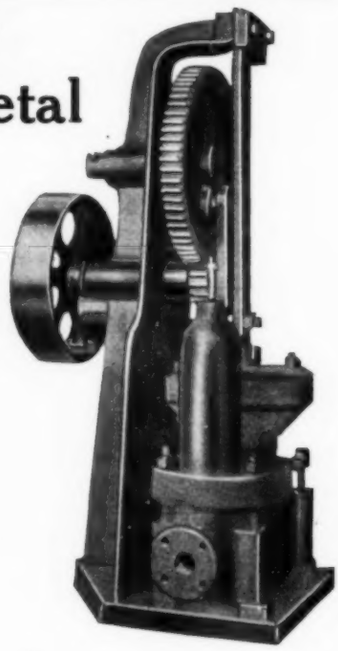

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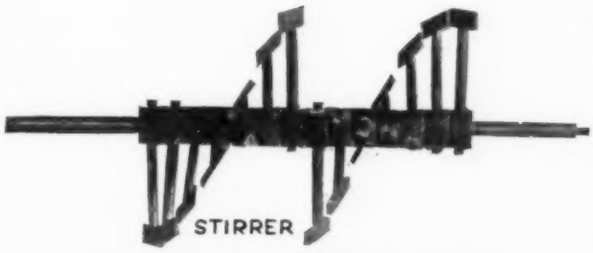

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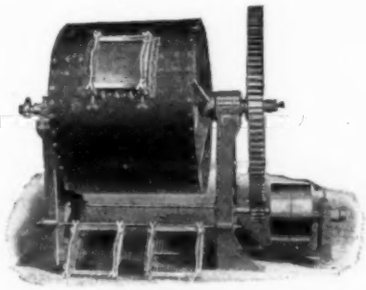

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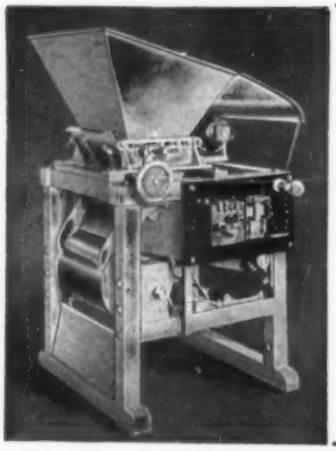

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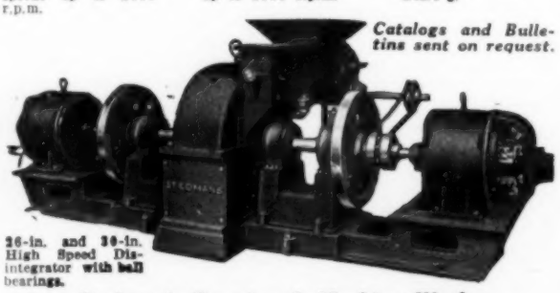

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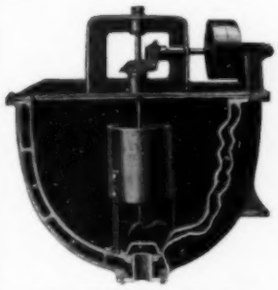

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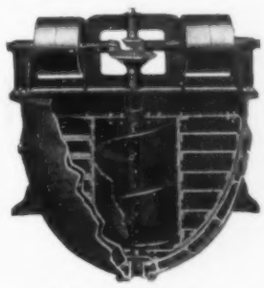

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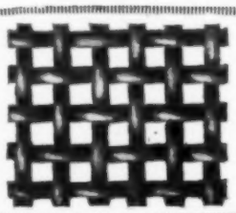

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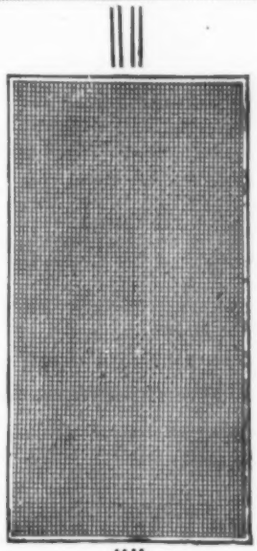

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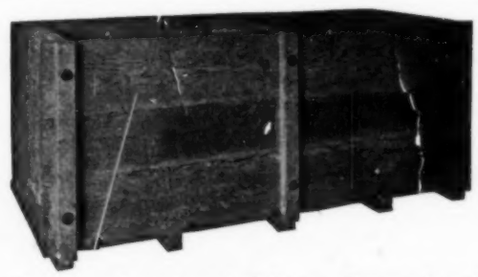

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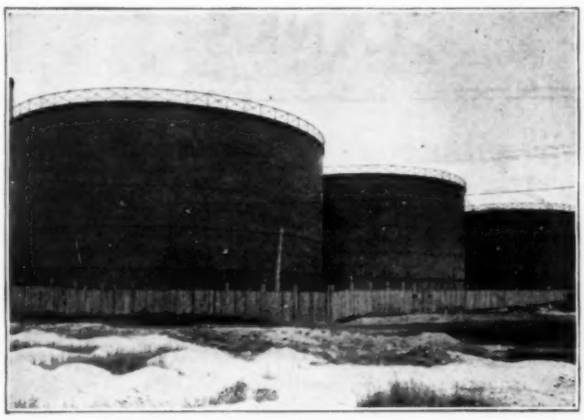

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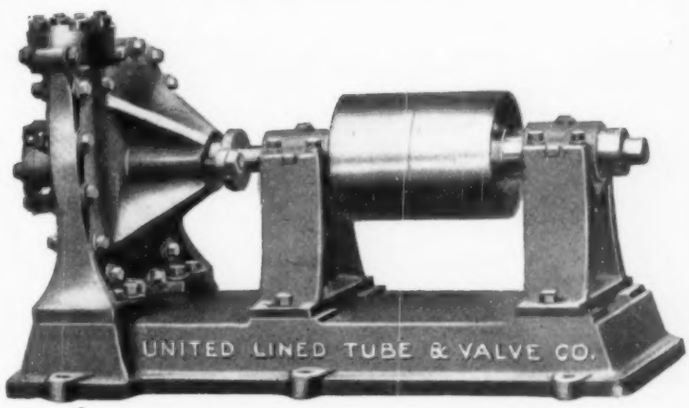

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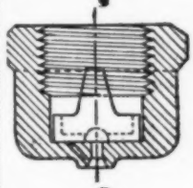

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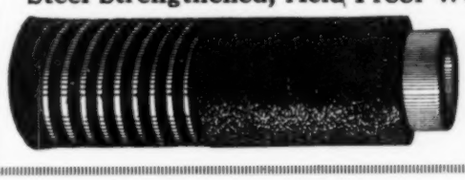

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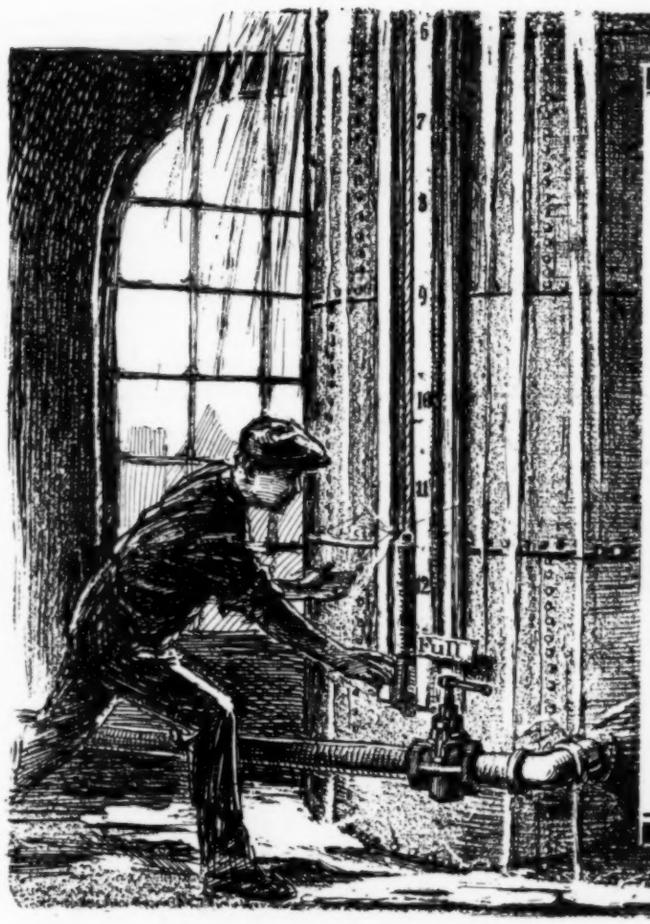

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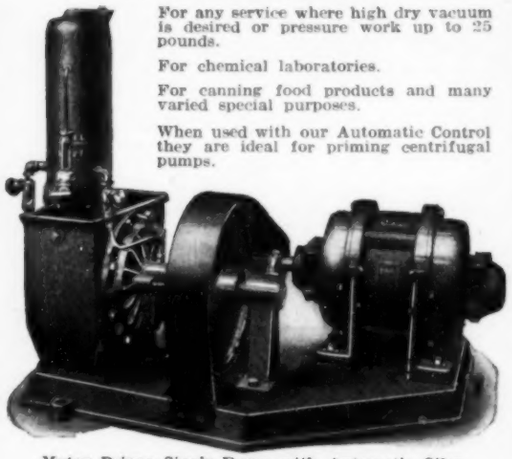

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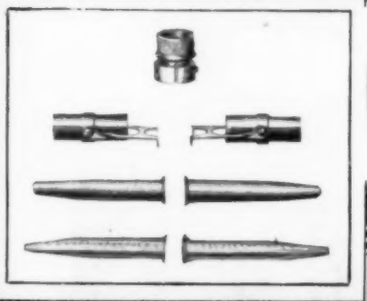

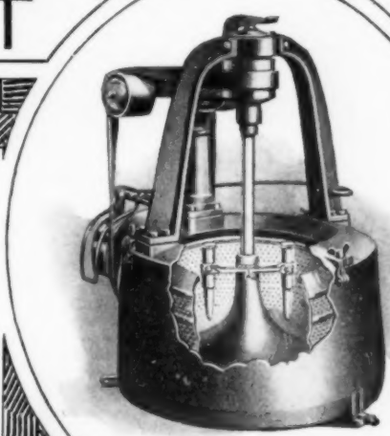

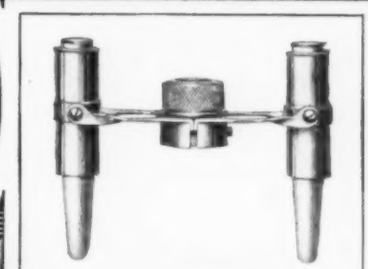

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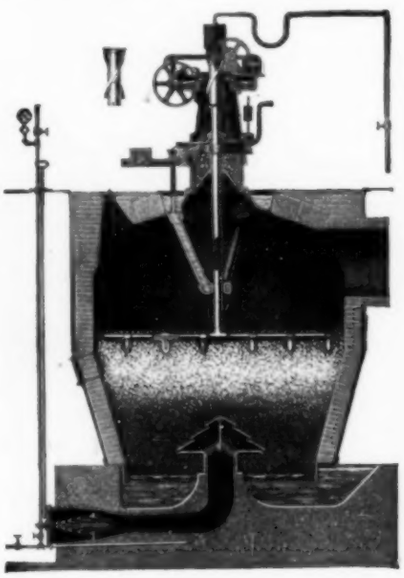

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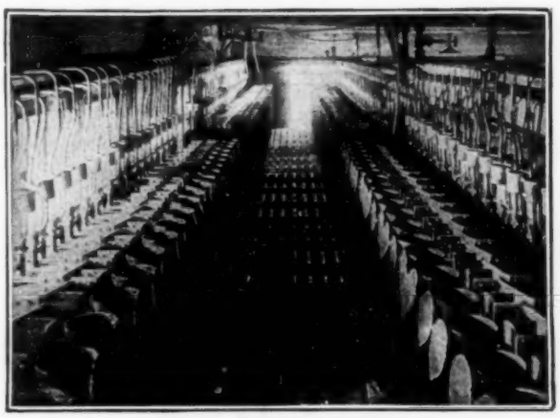

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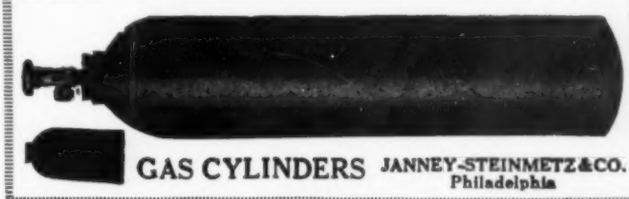

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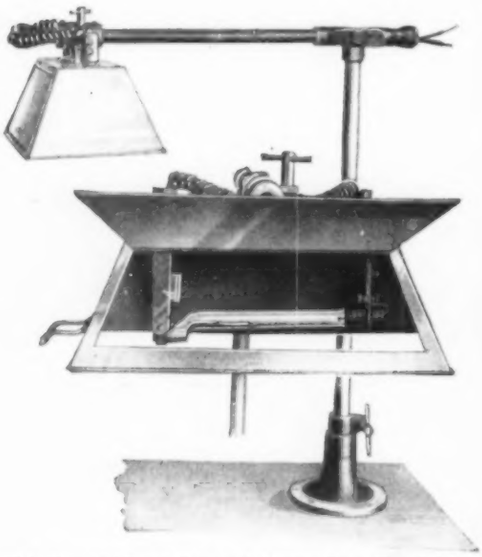

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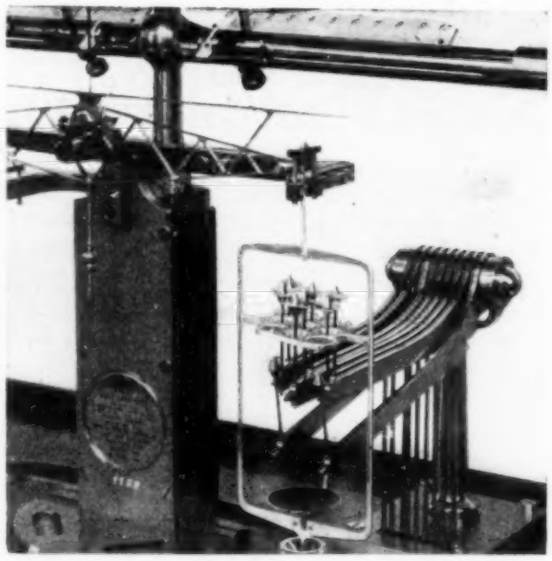

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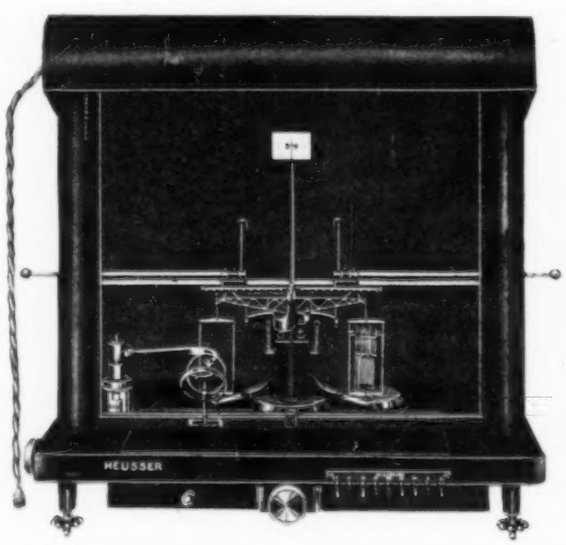
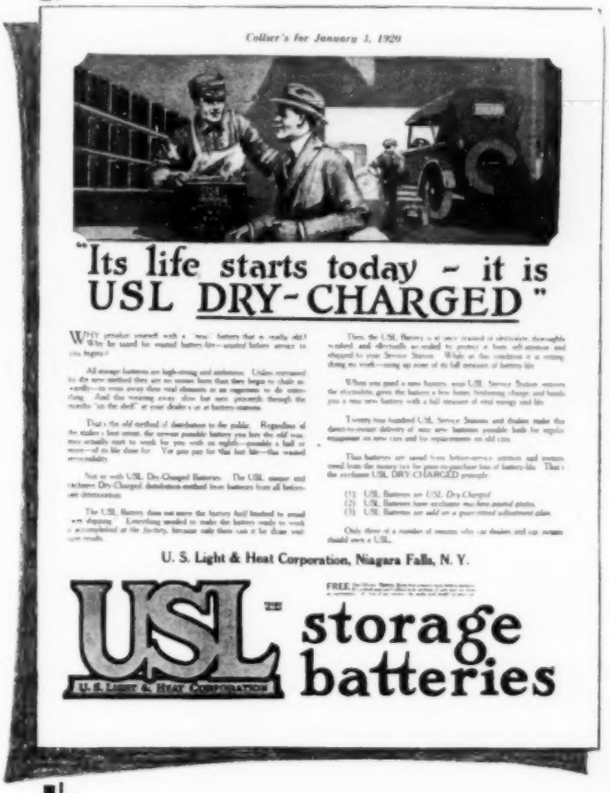


USL's Pledge to the public



Collier's for January 3, 1920

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Then the USL Battery is set away charged in electrolyte thoroughly matured and electrically sealed to protect it from self-attrition and shipped to your Service Station. While in this condition it is resting, doing no work—using up none of its all important of battery life.

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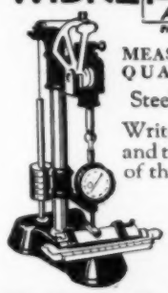

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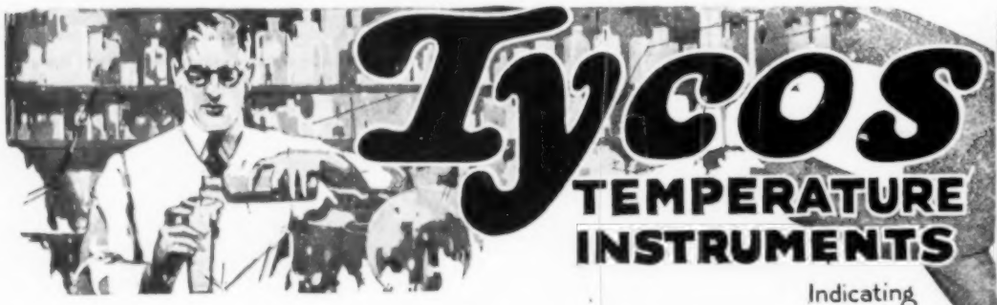

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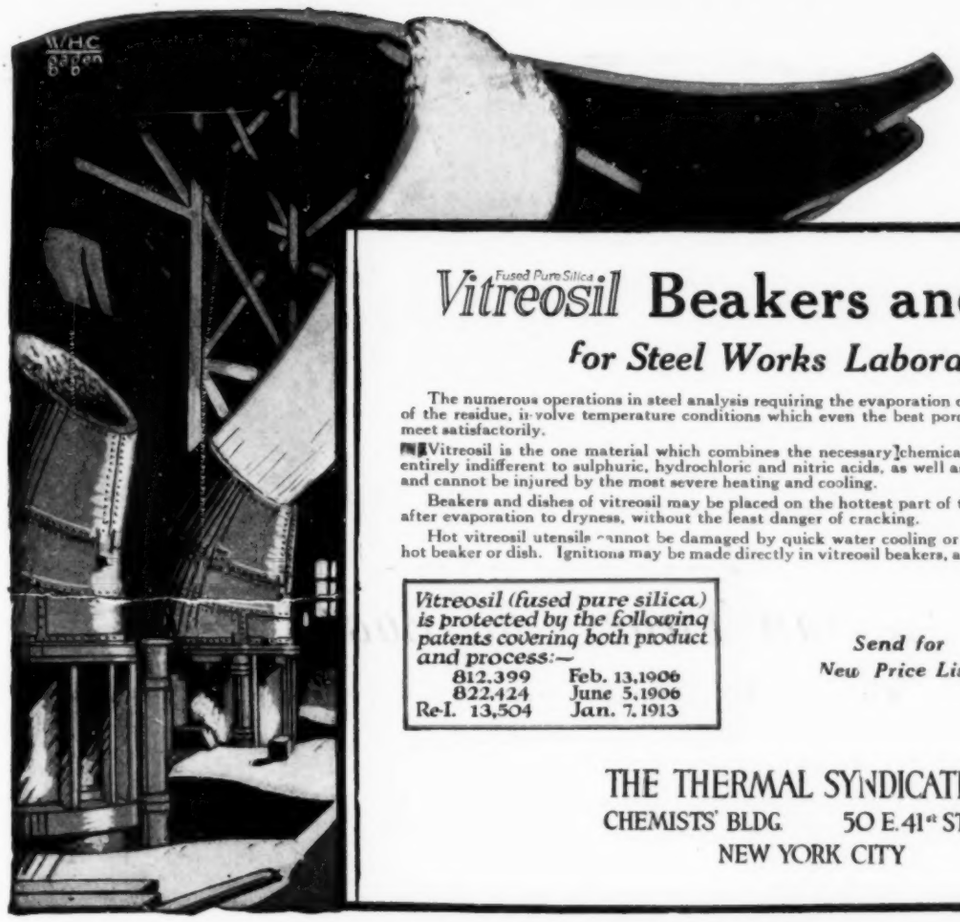

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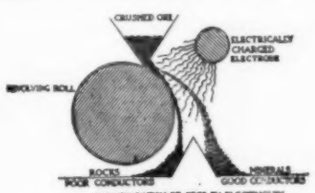

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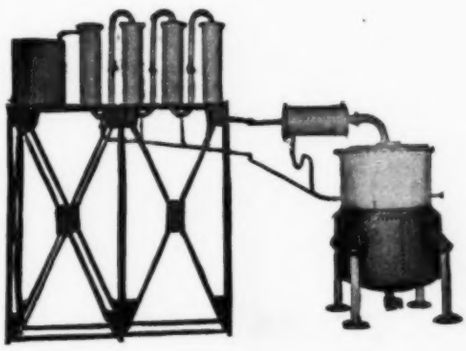

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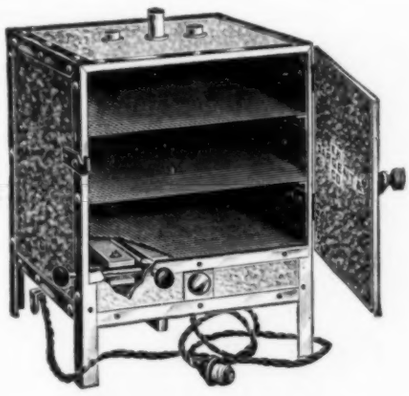

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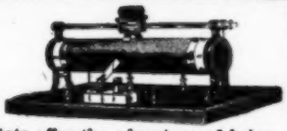

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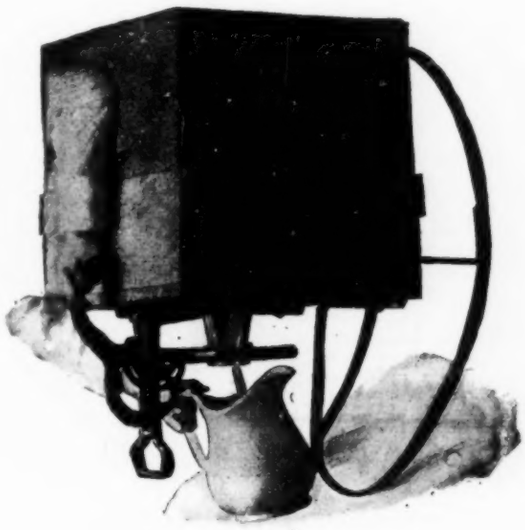

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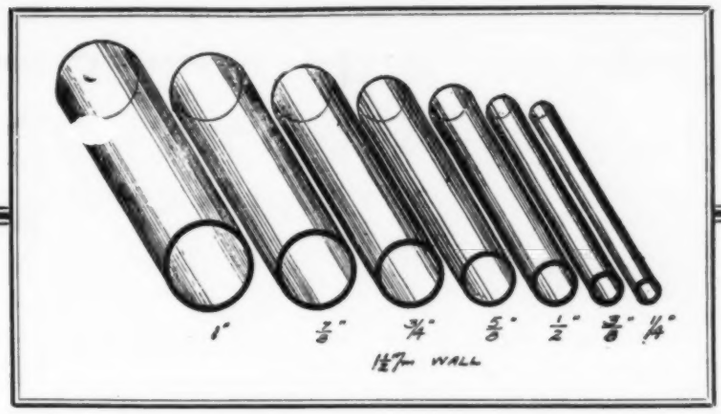

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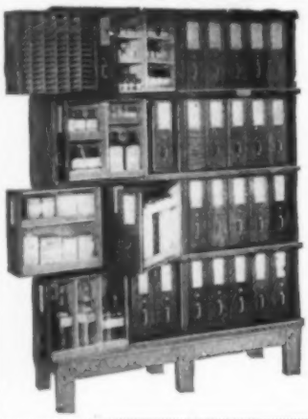

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New Eng. Tank & Tower Co.
Pacific Tank & Pipe Co.
Stearns Lumber Co., A. T.

Agitators
Baker Sons & Perkins Co.
Blaw-Knox Co.
Caldwell, W. E., Co.
Dorr Company, The
General Machine Co.
Johnsen Company, John
Lancaster Iron Wks., Inc.
New Eng. Tank & Tower Co.
Nickle Engineering Works.
Sowers Mfg. Co.

Air Compressors
Ingersoll-Rand Company
Taylor Instrument Cos.
Worthington Pump & Mach. Corp.

Air Conditioning
Atmospheric Conditioning Corp.

Air Conditioning App.
Atmospheric Conditioning Corp
Fleisher, W. L. & Co.
Spray Engineering Co.
Yarnall-Waring Co.

Air Lift Pumping Systems
Ingersoll-Rand Co.
Schutte & Koerting Co.
Worthington Pump & Mach. Corp.

Air Washers
American Blower Co.
Atmospheric Conditioning Corp.
Research Corp.

Alkalies
Solvay Process Co.

Alloys:
See Ferro-Alloys

Alloys, Special
Metal & Thermit Corp.

Aluminum
Aluminum Co. of Amer.

Analytical Apparatus
Ainsworth, Wm. & Son
Buffalo Apparatus Corp.
Central Scientific Co.
Daigger A.., & Co.
Denver Fire Clay Co.
Eimer & Amend
Hoskins Mfg. Co.
Mine & Smelter Supply Co.
Sargent, E. H. & Co.
Schaar & Co.
Thomas Co., A. H.
Widney Test Labs.

Analyzers, Gas
Foxboro Co., The
Mono. Corp. of America
Uehling Instrument Co.

Anodes, Graphite
Acheson Graphite Co.

Apparatus, Filtration
Permutit Co .

Arches, Furnace Combustion
Green Engineering Co.

Arsenic Acid Plants, Stoneware Acid Proof
Knight, Maurice A.

Ash Handling Mchy.
Bartlett & Snow Co.
Blaw-Knox Co.
Gifford-Wood Co.
Green Engineering Co.
Guarantee Constr. Co.
Jeffrey Mfg. Co.

Assayers
See Professional Directory Pages 69-71.

Autoclaves
Blaw-Knox Co.
Buffalo Fdry. & Mach. Co.
Devine, J. P., Co.
Duriron Co.
Sowers Mfg. Co.
Stokes Mach. Co., F. J.
Valley Iron Wks.

Automatic Car Drive Systems
Pratt Eng. & Mach. Co.

Balances and Weights
Ainsworth, Wm., & Son
Braun Corp., The
Braun-Knecht-Heimann Co.
Central Scientific Co.
Eimer & Amend
Mine & Smelter Supply Co.
Schaar & Co.
Scientific Materials Co.

Barometric Condensers
Buffalo Fdry. & Mach. Co.

Barrels, Steel, Bilge, Agitator and Open Head
Detroit Range Boiler and Steel Barrel Co.
Petroleum Iron Works

Baskets, Dipping
Newark Wire Cloth Co.

Battery Plate and Carbon
Stackpole Carbon Co.

Belt Conveyors
Barber-Greene Co.
Bartlett & Snow Co.
Caldwell, H. W. & Son
Gifford-Wood Co.
Jeffrey Mfg. Co., The
Link Belt Co.
Webster Mfg. Co.

Belt Fasteners
Crescent Belt Fastener Co.

Belting Silent Chain
Link-Belt Co.
Morse Chain Co.

Belt Hooks
Crescent Belt Fastener Co.

Belt Lacing
Crescent Belt Fastener Co.

Belt Rivets
Crescent Belt Fastener Co.

Bins Steel and Concrete
Brown Hoisting Mchry. Co.

Bleaching Powder
Electro-Bleaching Gas Co.
Mathieson Alkali Wks.

Blow Cases, Stoneware Acid Proof
Knight, Maurice A.

Blowers, Fan or Positive Pressure
Abbe Engineering Co.
American Blower Co.
American Keith Co.
Beach-Russ Co.
Buffalo Forge Co.
Connerville Blower Co.
Duriron Co.
Nash Eng. Co.
Roots, P. H. & F. M. Co.

Blowers, Flotation
Connersville Blower Co.
Nash Eng. Co.
Roots, P. H. & F. M., Co.

Boiler Covering
Celite Products Co.

Boiler Feed Water Purifying Apparatus
Permutit Co.

Boilers, Return Tubular
Coatesville Boiler Wks.

Boilers, Water Tube
Vogt, Henry Mach. Co.

Bolts and Nuts
International Nickel Co.

Bolting Cloth, Silk
Abbe Engineering Co.

Books, Technical
McGraw-Hill Book Co.

Bowls Mixing, Steel
Janney-Steinmetz Co.

Brick, Acid Proof
Denver Fire Clay Co.
General Ceramics Co.
Harbison-Walker Refractories Co.
Knight, Maurice A.
U. S. Stoneware Co.

Brick, Insulating
Celite Products Co.

Brick and Clay, Fire
Crescent Refractories Co.
Ironton Fire Brick Co.

Brimstone
Texas Gulf Sulphur Co.

Bronze, Titaniu. Aluminum
Titanium Alloy Mfg. Co.

Brushes Carbon
Stackpole Carbon Co.

Buckets, Clamshell & Drag Line
Blaw-Knox Co.
Brown Hoisting Mchry. Co.

Bucket Elevators
Bartlett & Snow Co.
Caldwell H. W. & Son Co.
Gifford-Wood Co.
Jeffrey Mfg. Co. The
Link-Belt Company
Webster Mfg. Co.

Buildings, Steel
Blaw-Knox Co.

Bunsen Burners
Detroit Heat. & Ltg. Co.
Tirrill Gas Mach. Ltg. Co.

Burners, Gas and Oil
Braun Corp., The
Braun-Knecht-Heimann Co.
Maxon Furnace & Eng. Co.
Monarch Mfg. Works
Schurs Oil Burner Co.
Schutte & Koerting Co.

Burners, Powdered Coal
Mine & Smelter Sup. Co.
Quigley Furnace Spec. Co.

Burners, Pyrite
Wedge Mech. Furnace Co.

Burners, Sulphur
Glens Falls Mach. Wks.
Pratt Eng. & Mach. Co.
Schutte & Koerting Co.

Cabinets, Laboratory
Schwartz Sectional System

Calorimeters
Central Scientific Co.
Eimer & Amend
Sargent, E. H., & Co.
Taylor Instrument Cos.

Carbon Projector
Stackpole Carbon Co.

Carboy Acid Lifts
Duriron Co.

Carboy Stoppers, Stoneware Acid Proof
Knight, Maurice A.

Cars, Industrial
Easton Car & Constr. Co.
Fairbanks, Morse & Co.

Cars, Mine and Ore
Easton Car & Constr. Co.
Mine & Smelter Supply Co.

Cars, Tank
General Amer. Tank Car Co.
Petroleum Iron Wks.

Cascade Basins, Acid Proof
Thermal Syndicate, Ltd.

Casseroles
Guernseyware Co.
Herold China & Pottery Co.

Castings
Jones Fdry. & Mach. Co.
Valley Mould & Iron Wks.
Webb City Coaterville Fdry. & Mach. Co.

Castings, Acid Proof
Bethlehem Fdy. & Mach. Co.
Buffalo Fdry. & Mach. Co.
International Nickel Co.
Pacific Foundry Co.
U. S. Cast Iron Pipe & Fdry. Co.
Valley Iron Wks.
Valley Mould & Iron Wks.

Castings, Bronze and Brass
Titanium Alloy Mfg. Co.

Castings, Chemical
Bethlehem Fdy. & Mach. Co.
Buffalo Fdy. & Mach. Co.
Duriron Co.
Fuller-Lehigh Co.
International Nickel Co.
Jacoby, Henry E.
Pacific Foundry Co.
Pratt Eng. & Mach. Co
Sperry, D. R., & Co.
U. S. Cast Iron Pipe & Fdy. Co.
Valley Iron Wks.
Valley Mould & Iron Wks.

Castings, Iron
Buffalo Fdy. & Mach. Co.
Cast Iron Pipe Pub. Bur.
Jones Fdry. & Mach. Co.
Sowers Mfg. Co.
Valley Mould & Iron Wks.

Castings, Lead
Craig Foundry Co.

Castings, Pure Copper
Titanium Alloy Mfg. Co.

Castings, Special & Chilled
Buffalo Fdry. & Mach. Co.
Fuller-Lehigh Co.
U. S. Cast Iron Pipe & Fdy. Co.
Valley Mould & Iron Wks.

Causticizing Apparatus
Buffalo Fdry. & Mach. Co.
Dorr Company, The
Scott, Ernest & Co.
Zaremba Co .

Caustic Soda and Chlorine Liquid (Electrolytic Cells for Making)
Electron Chemical Co
Pennsylvania Salt Mfg. Co.
Warner Chemical Co.

Caustic Soda and Chlorine
Electro Bleaching Gas Co.
Mathieson Alkali Wks.
Solvay Process Co.

Caustic Soda & Chlorine Plants
Bleach Process Co.

Cement, Acid Proof
Anti-Hydro Waterproofing Co.
Knight, Maurice A.

Cement, Cloth
Ludlow-Saylor Wire Co.

Cement, Furnace
Dixon, Jos., Crucible Co.
Quigley Furnace Spec. Co.

Centrifugals
American Tool & Machine Co.
Fletcher Works
Gillespie Works
Hepworth, S. S., Co.
Sharples Specialty Co.
Tolhurst Machine Wks.

Chain
Ryerson, Jos. T., & Son

Chains, Power Transmission
Link-Belt Co.
Morse Chain Co.

Chains, Sprocket Wheel
Morse Chain Co.

Chemical Cabinets
Schwartz Sectional System

Chemical Engines
Amer. La France Fire Eng. Co.

Chemical Equipment
R. U. V. Co.

Chemicals
Baker, J. T., Chem. Co.
Braun Corp., The
Braun-Knecht-Heimann Co.
Central Scientific Co.
Colorado Vanadium Co.
Cooper, Charles & Co.
Daigger, A., & Co.
Denver Fire Clay Co.
Eimer & Amend
Kastenhuber & Lehrfeld Co.
Mathieson Alkali Wks.
Merck & Co.
Pennsylvania Salt Mfg. Co.
Roessler & Hasslacher Chem. Co.
Sargent, E. H., & Co.
Schaar & Co.
Scientific Materials Co.
Solvay Process Co.
Will Corporation

Chemists, and Chem. Engrs.
See Professional Directory Pages 69-71.

Chemists, Mfg.
Baker J. T., Chem. Co.
Cooper, Charles & Co.
Eimer & Amend
Pennsylvania Salt Mfg. Co.
Roessler & Hasslacher Chem. Co.
Solvay Process Co.

Clarifying Filters
Merrill Co.

Clarifiers
Dorr Co.
Worthington Pump & Mach. Corp.

Clay Goods
See Brick and Clay, also Porcelain Ware, also Stoneware Chemical

Clutches, Friction
Jones Fdry. & Mach. Co.

Coal Handling Mchry.
Bartlett & Snow Co.
Gifford-Wood Co.
Guarantee Constr. Co.

Coal Tar Pitch
Barrett Co.

Cocks
See Valves and Cocks, Cast Iron, Acid Proof and Stoneware, Acid Proof

Coils, Copper
Badger, E. B., & Sons Co.
Whitlock Coil Pipe Co.

Coils or Worms, Stoneware
See Stoneware Chemical

Collectors, Dust
Buffalo Fdry. & Mach. Co.
Dust Recovering & Conveying Co.
Knickerbocker Co.
Research Corp.

Colonial Bermico Fibre Pipe
Colonial Supply Co.

Color Testing Equipment, Ultra Violet Ray
R. U. V. Co.

Combustion Boats
Englehard, Charles
McDanel Refractory Porcelain Co.

Combustion Equipment
American Engineering Co.
Green Engineering Co.
Mono Corp. of Amer.

Combustion Tubes
McDanel Refractory Porcelain Co.

Compressors, Air or Gas
Beach-Russ Co.
Connersville Blower Co.
Fairbanks, Morse & Co.
Nash Eng. Co.
Roots, P. H. & F. M., Co.

Concrete, Acid Resisting
Anti Hydro Water Proofing Co.

Concrete Construction
Blaw-Knox Co.

Condensers
Ingersoll-Rand Co.

Condensers, Barometric, Surface or Jet
Buffalo Steam Pump Co.
Devine Co., J. P.
Lummus Co., W. E.
Wheeler Condenser & Engrg. Co.
Wheeler Mfg. Co., C. H.
Worthington Pump & Mach. Corp.

Controllers Temperature
Crane Co.
Powers Regulator Co.

Conveyors, Pneumatic
Dust Recovering & Conveying Co.
Guarantee Constr. Co.
Holly Pneumatic Systems

Conveyors, Portable
Barber-Greene Co.
Jeffrey Mfg. Co.
Portable Machinery Co.
Stephens-Adamson Mfg. Co.

Copper Tubes, Seamless Drawn
Wheeler Condenser & Engrg. Co.

Coppersmithing
Badger & Sons Co.

Cranes
Brown Hoisting Machry. Co.

Cranes, Locomotives
Brown Hoisting Machry. Co.
Link-Belt Company

Crucibles, Graphite
Acheson Graphite Co.
Bartley Crucible Co.
Dixon Crucible Co.

Crucibles, Industrial
Acheson Graphite Co.
Bartley Crucible Co.
Dixon Crucible Co.
Thermal Syndicate, Ltd.

Crucibles, Laboratory
American Platinum Wks.
Denver Fire Clay Co.
Guernseyware Co.
Mine & Smelter Sup. Co.
Scientific Materials Co.

Crystallizing Dishes and Pans, Stoneware
See Stoneware, Chemical

Crystallizing Pans, Cast Iron
Buffalo Fdry. & Mach. Co.
Devine Co., J. P.

Cupels
Dixon Crucible Co.

Curb Boxes, Meter
Cast Iron Pipe Pub Bur.

Cutlery, Stainless Steel
American Stainless Steel Co.

Cylinders, Steel
Janney-Steinmetz Co.

Die Castings (Bronze)
Titanium Alloy Mfg. Co.

Diffusion Batteries
Amer. Chem. & Sugar Mach. Co.

Digesters
Blaw-Knox Co.
Elyria Enameled Prod. Co.
Glass Coating Co.
Swenson Evaporator Co.

Disintegrators
Jeffrey Mfg. Co., The
Stedman's Fdry. & Mach. Wks.

Distilleries for Industrial Alcohol
Lummus Co., The W. E.

Distilling Machinery & Apparatus
Amer. Chem. & Sugar Mach. Co.
Badger, E. B., & Sons Co.
Buffalo Fdry. & Mach. Co.
Detroit Heating & Ltg. Co.
Devine Co., J. P.
Duriron Co.
Eimer & Amend
Elyria Enameled Prod. Co.
Glass Coating Co.
Koven, L. O., & Bro.
Lummus Co., W. E.
Oakland Copper & Brass Wks.
Scientific Materials Co.
Scott, Ernest & Co.
Sowers Mfg. Co.
Stevens-Aylsworth Co.
Stokes Mach. Co., F. J.
Swenson Evaporator Co.
Zaremba Co.

Doors, Chain Screen
Codd, E. J., Co.

Drives, Silent Chain
Link-Belt Co.
Morse Chain Co.

Drop Forge Fittings
Vogt Mach. Co., Henry

Drums, Steel
Detroit Range Boiler and Steel Barrel Co.
Devine Co., J. P.
Petroleum Iron Wks.

Dry Cell Filler
Acheson Graphite Co.

Dryers, Centrifugal
Elmore, G. H.
Fletcher Works
Gillespie Motor Co.
Sharples Specialty Co.
Tolhurst Machine Wks.

Dryers, Vacuum
Buffalo Fdry. & Mach. Co.
Devine Co., J. P.
Jacoby, Henry E.
Scott, Ernest & Co.
Stokes Mach. Co., F. J.

Drying Mach. and Apparatus
American Blower Co.
American Process Co.
Bartlett & Snow Co.
Bay City Iron Co.
Buffalo Forge Co.
Buffalo Fdry. & Mach. Co.
Christie, L. R.
Devine Co., J. P.
Fleisher, W. L. & Co.
Fuller-Lehigh Co.
Gordon Dryer Corp'n.
Kalpberry Corporation
Koven, L. O., & Bro.
Philadelphia Drying Mach. Co.
Proctor & Schwartz, Inc.
Redfield Mechanical Co.
Ruggles-Coles Eng. Co.
Scott, Ernest & Co.
Stokes Machine Co., F. J.
Swenson Evaporator Co.
Vulcan Iron Works

Dumbwaiters, Electric
Kaestner & Hecht Co.

Duriron
Duriron Co.

Dust Collecting Systems and Engineers
Dust Recovering & Conveying Co.
Guarantee Constr. Co.
Holly Pneumatic Systems Inc.
Paxson, Geo. W., Co.
Pratt Eng. & Mach. Co.
Raymond Bros. Imp. Pul. Co.
Research Corp.

Dynamos, Electroplating
See Electroplating Dynamos

Dynamos and Motors
Jantz & Leist Elec. Co.
Westinghouse Elec. & Mfg. Co.

Educational Institutions
Alexander Hamilton Inst.

Ejectors or Steam Syphons
Duriron Co.

Electrical Precipitation
Research Corp.

Electric Testing Sets
American Transformer Co.

Electrodes, Carbon
Acheson Graphite Co.
National Carbon Co.
Stackpole Carbon Co.

Electrodes, Graphite
Acheson Graphite Co.

Electrolytic Cells
Electrolabs, Inc.
Electron Chemical Co.
Warner Chemical Co.

Electrolytic Oxygen & Hydrogen Generators
Electrolabs, Inc.

Electroplating Dynamos; Supplies
Eager Electric Co.
Jantz & Leist Elec. Co.

Electroplating Salts
Roessler & Hasslacher Chem. Co.

Elevators, Electric
Kaestner & Hecht Co.

Enameled App., Acid Resisting
Elyria Enameled Prod. Co.
Glass Coating Co.

Engineers, Chemical, Consulting, Analytical Industrial
See Professional Directory Pages 69-71.
Amer. Industrial Eng. Co.
Booth Elec. Furnace Co.
Filtration Engineers, Inc.
Fleisher, W. L., & Co.
Garrigue & Co., Wm.
General Machine Co.
Guarantee Constr. Co.
Koppers Co., The
Mantius Eng. Co.
O'Brien & Nicholl
Pratt Eng. & Machine Co.
Uehling Instrument Co.
Widney Test Labs.

Engineers, Combustion
Foxboro Co., The
Garrigue, Wm. & Co.
Green Engineering Co.
Improved Equipment Co.
Uehling Instrument Co.

Engineers, Construction
Guarantee Constr. Co.
Koppers Co., The
Research Corp.

Engineers, Filtration
Filtration Engineers, Inc.

Engineers, Furnace
Booth Elec. Furnace Co.
Hagan, Geo. J., Co.
Rockwell Co., W. S.

Engineers (Testing)
Widney Test Labs.

Engines, Oil
Ingersoll-Rand Co.

Engines, Steam and Hauling
Vulcan Iron Works

Ether Generating Plants
Lummus Co., The W. E.

Evaporating Dishes
Guernseyware Co.
Thermal Syndicate, Ltd.

Evaporators
Amer. Chem. & Sugar Mach. Co.
Badger & Sons Co.
Baker Sons & Perkins Co.
Blaw-Knox Co.
Buffalo Fdry. & Mach. Co.
Devine, J. P., Co.
Kestner Evaporator Co.
Koven, L. O., & Bro.
Lancaster Iron Wks., Inc.
Oakland Copper & Brass Wks.
Pratt Eng. & Mach. Co.
Redfield Mechanical Co.
Sperry, D. R., & Co.
Stokes Mach. Co., F. J.
Swenson Evaporator Co.
Wheeler Condensor & Engrg. Co.
Zaremba Co.

Exhausters
Roots, P. H. & F. M. Co.
Schutte & Koerting Co.

Extraction Plants, Tannins Logwood, Oil Seed, etc.
Lummus Co., The W. E.

Extractors
Amer. Chem. & Sugar Mach. Co.
Badger, E. B., & Sons Co.
Buffalo Fdry. & Mach. Co.
Devine, J. P. Co.
Koven, L. O., & Bros.
Lummus Co., W. E.

Extractors, Centrifugal
Fletcher Works
Gillespie Motor Co.
Sharples Specialty Co.
Tolhurst Machine Wks.

Fans
American Keith Co.
Buffalo Forge Co.
Phila. Drying Machy. Co.
Pratt Eng. & Mach. Co.
Proctor & Schwartz, Inc.
Raymond Bros. Impt. Pulv. Co.
Schutte & Koerting Co.
Vulcan Lron Works

Fans, Stoneware, Acid Proof
General Ceramics Co.

Fasteners, Belt
Crescent Belt Fastener Co.

Faucets, Stoneware, Acid Proof
See Stoneware, Chemical

Feeders
Bartlett & Snow Co.
Jeffrey Mfg. Co., The
Webster Mfg. Co.

Felts, Paper Makers
Albany Felt Co.

Ferro-Alloys
Lavino E. J., & Co.
Metal & Thermit Corp.
Titanium Alloy Mfg. Co.

Filing Cabinets
Schwartz Sectional System

Filter Cloth
Albany Felt Co.
United Filters Corp.

Filter Cloth, Metallic
Ludlow-Saylor Wire Co.
Multi-Metal Co., Inc.
Newark Wire Cloth Co.
Tyler Co., The W. S.
United Filters Corp.

Filtering Media
Celite Products Co.

Filter Paper
Eimer & Amend

Filter, Porous Porcelain
Herold China & Pottery Co.

Filter Presses
Abbe Engineering Co.
Amer. Continuous Filter Co.
Bay City Iron Co.
Industrial Filtration Corp.
Johnson Co., John
Kelly Filter Press Co.
Koven, L. O., & Bro.
Lungwitz, Emil E.
Merrill Co., The
Oliver Continuous Filter Co.
Patterson Fdry. & Mach. Co.
Shriver, T., & Co.
Sperry, D. R., & Co.
Sweetland Filter Press Co.
United Filters Corp.

Filters
Permutit Co.
United Filters Corp.

Filters, Air
Research Corp.

Filters, Oil
Permutit Co.
United Filters Corp.

Filters, Rotary Continuous
Amer. Continuous Filter Co.
Industrial Filtration Co.
Kelley Filter Press Co.
Oliver Continuous Filter Co.
Sweetland Filter Press Co.

Filters Suction Stoneware Acid Proof
General Ceramics Co.
Knight, Maurice A.
Chapman Eng. Co.
Flinn & Dreffein Co.
Hagan, Geo. J., Co.

Filters, Water
Hungerford & Terry
Permutit Co.
Scaife & Sons Co., Wm. B.
Stevens-Aylsworth Co.

Fire Extinguishers
Amer. La France Fire Eng. Co.

Floor Grating
Irving Iron Wks.

Flooring
Irving Iron Wks.

Flooring, Non-Slipping
Irving Iron Works
Ryerson & Son, Jos. T.

Floors and Pits, Acid Resisting
Anti-Hydro Waterprfg. Co.

Flotation Apparatus
Braun Corp., The
Braun-Knecht-Heimann Co.

Flotation Oil
Barrett Co., The

Forgings
International Nickel Co.

Formaldehyde Plants
Lummus Co., The W. E.

Foundry Supplies & Equipment
Paxson, Geo. W. Co.

Friction Clutches
Jones Fdry. & Mach. Co.

Furnaces, Caustic Pot
Industrial Furnace Corp.
Nickle Engineering Co

Furnace Doors, Chain
Codd, E. J., Co.

Furnace Facings and Linings
Acheson Graphite Co.
Celite Products Co.
Crescent Refractories Co.
Dixon Crucible Co.
Quigley Furnace Specialties Co.

Furnace Hoists
Brown Hoisting Mach. Co.

Furnace Insulating
Celite Products Co.

Furnaces, Assay
Braun Corp., The
Braun-Knecht-Heimann Co.
Denver Fire Clay Co., The
Mine & Smelter Supply Co.

Furnaces, Brass or Aluminum Melting
Booth Elec. Furnace Co.
Detroit Elec. Furnace Co.
Pittsburgh Elec. Furnace Co.

Furnaces, Electric
Booth Elec. Furnace Co.
Detroit Elec. Furnace Co.
Hamilton & Hansell, Inc.
Leavitt, C. W., & Co.
Pittsburgh Elec. Furnace Co.

Furnaces, Cupola Fdry.
Worthington Pump & Mach. Corp.

Furnaces Electric Lab'y
Brown Instrument Co.
Central Scientific Co.
Eimer & Amend
Electric Htg. App. Co.
Engelhard Chas.
Hoskins Mfg. Co.

Furnaces, Heat Treating
Brown Instrument Co.
Electric Htg. App. Co.
Engelhard Chas.
Fuller Eng. Co.
Hagan, Geo. J., Co.
Hoskins Mfg. Co.

Furnaces, Melting Oil, Gas or Powdered Coal
Hagan, Geo. J., Co.

Furnaces, Muffle
Electric Htg. App. Co.
Hoskins Mfg. Co.
Improved Equipment Co.

Furnaces, Roasting & Smeltg.
Wedge Mechanical Furnace Co.
Worthington Pump & Mach. Corp.

Furnaces, Sulphur
Pacific Fdry. Co.
Pratt Eng. & Machine Co.

Fused Silica
General Ceramics Co.
Thermal Syndicate, Ltd

Gas Analysis Instruments
Mono Corp. of Amer.

Gas Machines
Detroit Heating & Ltg. Co.
Tirrill Gas Mach. Ltg. Co.

Gas Ovens
Improved Equipment Co.
Koppers Co., The
Morgan Construction Co.
Smith Gas Eng. Co.
Steere Eng. Co.

Gas Scrubbers and Washers
Bartlett Hayward Co.
Buffalo Forge Co.
Gas Engineering Co.
Research Corp.

Gauges, Recording, Indicating, Draft, Pressure
Bailey Meter Co.
Bristol Co., The
Brown Instrument Co.
Foxboro Co., The
Schaeffer & Budenberg Mfg. Co.
Taylor Instrument Cos.
Thwing Instrument Co.
Uehling Instrument Co.
Widney Test Labs.

Gears
Caldwell & Son Co.
Jones Fdry. & Mach. Co.

Gears, Compensating
Morse Chain Co.

Gears, Silent
Jones Fdry. & Mach. Co.

Generators
See Dynamos and Motor

Generators (Oxygen and Hydrogen)
Electrolabs, Inc.

Glass Blowing
Eimer & Amend
International Glass Co.

Glassware, Chemical
Central Scientific Co.
Eimer & Amend
Griebel Instrument Co.

Heil Chemical Co. Henry International Glass Co. Kimble Glass Co. Scientific Materials Co. Will Corporation, The

Graphite
Acheson Graphite Co.

Grating, Subway
Irving Iron Wks. Co.

Grinders
See Machinery, Crushing, Grinding and Pulverizing

Grinding Mill Jars
McDanel Refractory Porcelain Co.

Heater, Feed Water
Whitlock Coil Pipe Co.

Heat Exchange Apparatus
Whitlock Coil Pipe Co.

Heating App. & Systems
American Blower Co.
Atmospheric Cond. Corp.
Buffalo Forge Co.
Fleisher, W. L., & Co.
Parks-Cramer Co.
Powers Regulator Co.
Ruggles-Coles Eng. Co.

Heating Regulators
Powers Regulator Co.

Heat Insulation
Celite Products Co.

Hoists
Fairbanks, Morse & Co.
Jones Fdry. & Mach. Co.

Hoists, Portable
Ingersoll-Rand Co.

Hose
Ingersoll-Rand Co.

Hot Water Storage Heater
Whitlock Coil Pipe Co.

Hydro Carbons, Technical
Robertson Co., H. H.

Hydrogen Generating App.
Electrolabs. Inc.

Hydrogen Plants
Electrolabs. Inc.
Improved Equipment Co.

Hydrometers
Brown Instrument Co.
International Glass Co.

Instruments, Electrical and Testing
Bristol Co., The
Eimer & Amend
Hoskins Mfg. Co.
Precision Them. & Inst. Co.
Pyroelectric Instrument Co.
Schaeffer & Budenberg Mfg. Co.
Stupakoff Laboratories
Thwing Instrument Co.
Uehling Instrument Co.
Valley Iron Wks.
Westinghouse Elec. & Mfg. Co.
Widney Test Labs.
Wilson-Maulen Co.

Insulating Material, Elec.
Redmanol Chem. Prod. Co.

Jackets, Paper Makers
Albany Felt Co.

Jigs
Worthington Pump & Mach. Corp.

Kettles, Cast Iron, Acid Proof
Bethlehem Fdry. & Mach. Co.
Buffalo Fdry. & Mach. Co.
Devine, J. P., Co.
Durrion Co.
Pacific Fdry. Co.
Stevens-Aylsworth Co.
U. S. Cast Iron Pipe & Fdy. Co.
Valley Iron Wks.

Kettles, Enameled, Acid Proof
Elyria Enameled Prod. Co.
Glass Coating Co.

Kettles, Steam-Jacketed
Baker Sons & Perkins Co.
Buffalo Fdy. & Mach. Co.
Day, J. H., Company
Detroit Heat'g. & Ltg. Co.
Devine Co., J. P.
Duriron Co.
Glass Coating Co.
Pratt Engr. & Mach. Co.
Sowers Mfg. Co.
Stevens-Aylsworth Co

Kiln, Lime
Crescent Refractories Co.
Maxon Furnace & Eng. Co.
Vulcan Iron Works

Kiln, Rotary and Nodulizing
American Process Co.
Ruggles-Coles Eng. Co.
Vulcan Iron Works

Laboratory App. & Supplies
Baker Sons & Perkins Co.
Braun Corp., The
Braun-Knecht-Heimann Co.
Buffalo Apparatus Corp.
Daigger, A., & Co.
Detroit Heat. & Light Co.
Eimer & Amend
Griebel Instrument Co.
Guernseyware Co.
Heil Chemical Co.
Hoskins Mfg. Co.
International Glass Co.
Mine & Smelter Supply Co.
Pyroelectric Instrument Co.
Sargent, E. H. & Co.
Schaar & Co.
Scientific Materials Co.
Thomas Co., A. H.
Tirrill Gas Mach. Ltg. Co.
Widney Test Labs.
Will Corporation, The

Laboratory Furniture
Schwartz Sectional System

Lacing Belt
Crescent Belt Fastener Co.

Lifts, Air Jet
Bethlehem Fdy. & Mach. Co.
Lummus Co., W. E.
Monarch Mfg. Wks., Inc.

Lime Chemical
Mitchell Lime Co.

Lime, Hydrated
Mitchell Lime Co.

Loaders, Wagon & Truck
Barber-Greene Co.
Gifford-Wood Co.

Locomotives, Industrial
Jeffrey Mfg. Co., The
Vulcan Iron Works

Machine and Engine Parts
American Stainless Steel Co.

Machinery, Agitating
Baker Sons & Perkins Co.
Buffalo Fdy. & Machine Co.
Day, J. H., Co.
Dorr Co., The
Gedge-Gray Co.
Johnson Co., John
Kaestner & Hecht Co.
New England Tank & Tower Co.
Sowers Mfg. Co.

Machinery, Automatic Weighing
Baker Sons & Perkins Co.
Schaffer Eng. & Equip. Co.

Machinery, Classifying
Dorr Co., The

Machinery, Coal Grinding
Aero Pulverizing Co.
Jeffrey Mfg. Co.
Pratt Eng. & Machine Co.
Raymond Bros. Impt. Pulv. Co.

Machry., Conveying & Elevating
Bartlett & Snow Co.
Caldwell, H. W., & Son Co.
Dust Recovering & Conveying Co.
Gifford-Wood Co.
Holly Pneumatic Systems, Inc.
Jeffrey Mfg. Co.
Jones Fdry. & Mach. Co.
Link-Belt Company
Stephens-Adamson Mfg. Co.
Valley Iron Wks.
Webster Mfg. Co.

Machinery, Crushing, Grinding and Pulverizing
Abbe Engineering Co.
Aero Pulverizer Co.
Buchanan, C. G., & Co.
Day, J. H., Company
Fuller-Lehigh Co
Jeffrey Mfg. Co.
Kaestner & Hecht Co.
Kent Mill Co.

Mine & Smelter Supply Co.
Patterson Fdry. & Mach. Co.
Pratt Eng. & Mach. Co.
Raymond Bros. Imp. Pulv. Co.
Stedman's Fdry. & Mach. Wks.
Sturtevant Mill Co.
Vulcan Iron Works
Worthington Pump & Mach. Corp.

Machinery, Crushing, Grinding and Pulverizing Laboratory
Abbé Engineering Co.
Aero Pulverizer Co.
Braun Corp., The
Braun-Knecht-Heimann Co.
Jeffrey Mfg. Co.
Sturtevant Mill Co.
Worthington Pump & Mach. Corp.

Machinery, Cyanide
Dorr Co., The
Worthington Pump & Mach. Corp.

Machinery, Dyeing
Philadelphia Drying Machy. Co.

Machinery, Metallurgical
Abbé Engineering Co.
Aero Pulverizer Co.
American Continuous Filter Co.
Dorr Co., The
Huff Electrostatic Sep. Co.
Ingersoll-Rand Co.
Jones Fdry. & Mach. Co.
Kelly Filter Press Co.
Kent Mill Co.
Lungwitz, Emil E.
Mine & Smelter Supply Co.
Pacific Fdry. Co.
Raymond Bros. Imp. Pulv. Co.
Ruggles-Coles Eng. Co.
Sturtevant Mill Co.
Sweetland Filter Press Co.
Tyler Co., The W. S.
United Filters Corp.
Vulcan Iron Works Co.
Worthington Pump & Mach. Corp.

Machry., Mixing & Kneading
Abbé Engineering Co.
Baker Sons & Perkins Co.
Bartlett & Snow o.
Buffalo Fdry. & Mach. Co.
Day, J. H., Company
Gedge-Gray Co., The
Kaestner & Hecht Co.
New England Tank & Tower Co.
Patterson Fdry. & Mach. Co.
Pratt Eng. & Mach. Co.
Sowers Mfg. Co.

Machinery, Ore Concentrating
Dorr Co., The
Kent Mill Co.
Mine & Smelter Supply Co.
Ruggles-Coles Eng. Co.
Worthington Pump & Mach. Corp.

Machry., Ore & Coal Handling
Barber-Greene Co.
Gifford-Wood Co.
Guarantee Constr. Co.
Jeffrey Mfg. Co.
Link-Belt Co.
Stephens-Adamson Mfg. Co.
Webster Mfg. Co.

Machinery, Refrigerating
Vogt Machine Co.
York Mfg. Co.

Machinery, Screening
Gifford-Wood Co.
Jeffrey Mfg. Co.
Stephens-Adamson Mfg. Co.
Tyler Co., The W. S.
Webster Mfg. Co.
Worthington Pump & Mach. Corp.

Machinery, Special
Baker Sons & Perkins Co.
Buffalo Fdry. & Mach. Co.
Day, J. H., Company
Jones Fdry. & Mach. Co.
Kaestner & Hecht Co.
Stevens-Aylsworth Co.

Machinery, Thickening and Dewatering
Baker Sons & Perkins Co.
Buffalo Fdry. & Mach. Co.
Dorr Co., The

Machnery, Transmission
Caldwell & Son Co.
Jeffrey Mfg. Co.
Jones Fdry. & Mach. Co.
Morse Chain Co.
Stephens-Adamson Mfg. Co.
Webster Mfg. Co.

Machinery, Turbine
De Laval Steam Turbine Co.

Machinery, Weighing
Baker Sons & Perkins Co.
Schaeffer Eng. & Equip. Co.
Sturtevant Mill Co.

Machine Tools
Ryerson, Jos. T. & Son

Magnesia, Electrically Sintered
Norton Co., The

Magnesium Metal
American Magnesium Corp.
Leavitt, C. W., & Co.

Magnetic Pulleys
Dings Magnetic Sep. Co.
Magnetic Mfg. Co.

Magnetic Separators
Buchanan, C. G., Co., Inc.
Dings Magnetic Sep. Co.
Magnetic Mfg. Co.

Magnets
Dings Magnetic Sep. Co.
Magnetic Mfg. Co.

Magnets, Lifting
Cutler-Hammer Mfg. Co.,

Manganese Ore
Lavino E. J., & Co.

Metallurgical Engineers
See Professional Directory Pages 69-71.

Metals and Alloys
Metals Disintegrating Co.
Metal & Thermit Corp.

Metal Working Machinery
Ryerson, Jos. T., & Son

Meter Box Covers
Cast Iron Pipe Pub. Bur.

Meters, Flow, Air, Gas, Water
Bailey Meter Co.
Spray Engineering Co.
Yarnall-Waring Co.

Microscopes
Scientific Materials Co.

Mills, Ball, Pebble and Tube
Abbé Engineering Co.
International Nickel Co.
Mine & Smelter Supply Co.
Patterson Fdry. & Mach. Co.
Worthington Pump & Mach. Corp.

Mills, Emery
Sturtevant Mill Co.

Minerals and Ores
American Magnesium Co.
Kastenhuber & Lehrfeld

Mixers, Batch
Baker Sons & Perkins Co.

Monel Metal
International Nickel Co.
Multi-Metal Co., Inc.

Motors, Electric
Fairbanks, Morse & Co.
Westinghouse Elec. Mfg. Co.

Motor Trucks
Packard Motor Car Co.

Muriatic Acid Plants, Stoneware Acid Proof
Knight, Maurice A.

Nitrating Kettles, Stoneware Acid Proof
Knight, Maurice A.

Nitric Acid Plants
Buffalo Fdry. & Mach. Co.

Nozzles, Spray
American Blower Co.
Buffalo Forge Co.
Monarch Mfg. Wks., Inc.
Schutte & Koerting Co.
Spray Engineering Co.
Yarnall-Waring Co.

Oil & Grease Extraction Equipment
Bartlett & Snow Co.
Redfield Mechanical Co.

Ores
See Minerals and Ores

Ore Bedding and Reclaiming Systems
Stephens-Adamson Mfg. Co.

Ovens, Laboratory
Reynolds, Teschner & Volk Co.
Thermo Electric Inst. Co.

Oxygen and Hydrogen Generating Equipment
Electrolabs. Inc.

Paint Grinding Mach.
Kaestner & Hecht Co.

Paint Mixing Mach.
Kaestner & Hecht Co.

Paint, Pigment, Graphite
Acheson Graphite Co.

Paints, Acid Proof and Technical
Toch Bros

Palau Ware
Braun Corp.
Braun-Knecht-Heimann Co.

Pans, Vacuum
Amer. Chem. & Sugar Mach. Co.
Badger & Sons Co.
Baker Sons & Perkins Co.
Buffalo Fdry. & Mach. Co.
Devine Co., J. P.
Kestner Evaporator Co
Lummus Co., W. E.
Sowers Mfg. Co.
Swenson Evaporator Co.
Wheeler Condenser & Engrg. Co.
Zaremba Co.

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Pipe, Cast Iron
Cast Iron Pub. Bur.
U. S. Cast Iron Pipe & Fdy. Co.

Pipe, Silica Ware
General Ceramics Co.
Thermal Syndicate, Ltd.

Pipe and Fittings, Cast Iron Acid Proof
Crane Co.
Duriron Co.
Glass Coating Co.
Pacific Fdry. Co.

Pipe and Fittings, Copper
Badger & Sons Co.
Lummus Co., W. E.
Whitlock Coil Pipe Co.

Pipe and Fittings Lead, Tin or Silver Lined
Badger & Sons Co.
Cleveland Brass Mfg. Co.
United Lead Co.

Pipe and Fittings, Stoneware, Acid Proof
General Ceramics Co.
Knight, Maurice A.
U. S. Stoneware Co.

Pipe and Fittings, Wood
Michigan Pipe Co.
National Tank & Pipe Co.
Pacific Fdry. Co.
Pacific Tank & Pipe Co.

Pipe Covering Wood
Michigan Pipe Co.

Platinum Wire, Sheet and Foil, Crucibles, Dishes, Electrodes, Laboratory Ware, all kinds
American Platinum Wks.
Baker & Co., Inc.
Bishop J., & Co., Plat. Wks.
Kastenhuber & Lehrfeld

Pneumatic Tools
Ingersoll-Rand Co.

Porcelain Ware
Guernseyware Co.
Herold China & Pottery Co.

Pots, Cast Iron, Acid Proof
Baker Sons & Perkins Co.
Bethlehem Fdry. & Mch. Co.
Buffalo Fdry. & Mach. Co.
U. S. Cast Iron Pipe & Fdy. Co.
Valley Mould & Iron Wks.

Pots and Pans, Steel
Janney-Steinmetz Co.

Pots or Jars, Stoneware, Acid Proof
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Powdered Coal Equipment
Aero Pulverizer Co.
American Industrial Eng. Co.
Fuller Eng. Co.
Raymond Bros. Imp. Pul. Co.

Power Transmission
Jones Fdry. & Mach. Co.

Precipitation Processes
Merrill Co., The

Precipitators, Centrifugal
American Tool & Mach. Co.
Fletcher Works

Pulleys, Cast Iron
Jones Fdry. & Mach. Co.

Pulleys, Friction Clutch
Jones Fdry. & Mach. Co.

Pulleys, Magnetic
Dings Magnetic Sep. Co.

Pump Lines
International Nickel Co.

Pumps, Acid or Acid Gases
Abbé Engineering Co.
American Well Works
Beach-Russ Co.
Chemical Equipment Co.
Duriron Co.
Elmore, G. H.
General Ceramics Co.
Goulds Mfg. Co.
Lummus Co., W. E.
Nash Engineering Co.
Rumsey Pump Co.
United Lead Co.
Worthington Pump & Mach. Corp.

Pumps, Brine
Cameron Steam Pump Wks. Co.

Pumps, Centrifugal
Abbé Engineering Co.
American Well Wks.
Cameron Steam Pump Wks. Co.
Duriron Co.
Goulds Mfg. Co.
Schutte & Koerting Co.
Taber Pump Co.
Worthington Pump & Mach. Corp.

Pumps, Diaphragm
Cameron Steam Pump Wks. Co.
Goulds Mfg. Co.
Johnson Co., John

Pumps, Fire
American Well Works

Pumps, Gas, Liq., or Vacuum
Beach-Russ Co.
Buffalo Fdry & Mach. Co.
Devine, J. P., Co.
Fairbanks, Morse & Co.
Goulds Mfg. Co.
Nash Engrg. Co.

Pumps, Mine
American Well Wks.
Cameron Steam Pump Wks. Co.

Pumps, Piston
Cameron Steam Pump Wks.

Pumps, Rotary, Oil or Water
Goulds Mfg. Co.
Rumsey Pump Co., Ltd.
Taber Pump Co.

Pumps, Sand
Krogh Pump Mfg. Co.

Pumps, Stoneware, Acid Proof
General Ceramics Co.

Pumps, Triplex
Goulds Mfg. Co.

Pumps, Vacuum
Buffalo Fdry. & Mach. Co.
Ingersoll-Rand Co.
Lammert & Mann Co.
Wheeler Mfg. Co., C. H.

Pyrometer Protection Tubes
Engelhard, Charles
Herold China & Pottery Co.
McDanel Refractory Porcelain Co.
Stupakoff Laboratories
Thermal Syndicate, Ltd.

Pyrometers
Bristol Co., The
Brown Instrument Co.
Buffalo Apparatus Corp.
Cleveland Instrument Co.
Engelhard, Chas.
Hoskins Mfg. Co.
Pyroelectric Instrument Co.
Sargent, E. H., & Co.
Shaeffer & Budenberg Mfg. Co.
Stupakoff Laboratories
Taylor Instrument Co.
Thwing Instrument Co.
Wilson-Maulen Co.
Uehling Instrument Co.

Pyrometer Sheets, Graphite
Acheson Graphite Co.

Railway, Industrial and Portable
Easton Car & Constr. Co.

Reagent Cabinets
Schwartz Sectional System

Receivers, Stoneware Acid Proof
Knight, Maurice A.

Recording Instruments, Pressure Temperatures Electricity, Motion, Speed, Time
Bristol Co., The
Cleveland Instrument Co.
Foxboro Co., The
Precision Therm. & Inst. Co.
Pyroelectric Instrument Co.
Schaeffer & Budenberg Mfg. Co.
Thomas Co., A. H.
Thwing Instrument Co.
Uehling Instrument Co.
Widney Test Laboratories
Wilson-Maulen Co.

Reducers, Speed
Jones Fdry. & Mach. Co.

Regulators, Pressure and Temperature
Bailey Meter Co.
Crane Co.
Foxboro Co., The
Lummus Co., W. E.
Powers Regulator Co.

Respirators
Amer. La France Fire Eng. Co.
Multi-Metal Co., Inc.

Retorts
See Acid Distillation App.

Retorts, Graphite
Bartley Crucible Co.

Retorts, Vertical
Buffalo Fdry. & Mach. Co.

Rhodium
Kastenhuber & Lehrfeld

Rivets, Belt
Crescent Belt Fastener Co.

Rolls, Crushing
Jeffrey Mfg. Co.

Safety Devices
Amer. La France Fire Eng. Co.

Sample Cabinets
Schwartz Sectional System

Scales Conveyor
Schaeffer Eng. & Equip. Co.

Scales Weighing
Baker Sons & Perkins Co.
Fairbanks Morse & Co.
Sturtevant Mill Co.

Schools and Colleges
Hamilton Institute Alexander

Screening Machinery
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Screens
Newark Wire Cloth Co.
Patterson Fdry. & Mach. Co.
Stephens-Adamson Mfg. Co.
Sturtevant Mill Co.

Screens, Mining
Ludlow-Saylor Wire Co.

Screens, or Cloth, Fertilizer
Ludlow-Saylor Wire Co.

Screens, Wire, Brass, Copper, Steel, etc.
Ludlow-Saylor Wire Co.
Multi-Metal Co., Inc.
Tyler Co., The W. S.

Second Hand Equipment
See Searchlight Section Pages 59-68.

Apex Pulverizing Mills
Consolidated Products Co.
Continental Mach. Co.
Du Pont Chem.Co., Inc.

Separators Air
Raymond Bros. Imp. Pulv. Co.

Separators, Centrifugal
American Tool & Mach. Co.
Fletcher Works
Sharples Specialty Co.
Tolhurst Mach. Wks.

Separators, Electrostatic
Huff Electrostatic Sep. Co.

Separators, Inclined Vibrating Screen
Sturtevant Mill Co.
Tyler Co., The W. S.

Separators, Magnetic
Ding's Magnetic Sep. Co.
Magnetic Mfg. Co.
Paxson, Geo. W., Co.

Shafting
Jones Fdry. & Mach. Co.

Sieves, Laboratory
Multi-Metal Co., Inc.
Newark Wire Cloth Co.

Sinks, Laboratory, Stoneware Acid Proof
Knight, Maurice A.

Slime Filters
Merrill Co., The

Soda, Ash
Solvay Process Co.

Soda, Washing
Solvay Process Co.

Solvent Recovery Installations
Lummus Co., W. E.

Specimen Cabinets
Schwartz Sectional System

Spiegeleisen
Lavino, E. J., & Co.

Spray Systems
Chemical Equipment Co.
Spray Engineering Co.
Yarnall-Waring Co.

Sprockets
Jones Fdry. & Mach. Co.

Sprockets, Compensating
Morse Chain Co.

Sprockets, Silent Chain
Morse Chain Co.

Steam Jacketed Kettles
Sowers Mfg. Co.

Steel, High Speed
Ryerson, Jos. T. & Son.
Standard Alloys Co.

Steel Merchants
Ryerson, Jos. T. & Son.

Steel Plate Construction
Chicago Bridge & Iron Wks.
Sharpsville Boiler Wks.

Steel, Stainless
American Stainless Steel Co.

Steel, Structural
Ryerson, Jos. T. & Son

Sterilizers, Ultra Violet Ray
R. U. V. Co.

Stirrers, Acid Proof
Acheson Graphite Co.
Duriron Co.

Stokers
American Engineering Co.
Green Engineering Co.
Hagan, Geo. J., Co.
Under-Feed Stoker Co.

Stoneware, Acid Proof Chem.
Knight, Maurice A.

Stoneware, Chemical, consisting of:
Bottles, Carboy Stoppers Coils and Worms, Crystallizing Dishes, Chlorine Generators, Decanting Pots, Dippers, Faucets, Funnel, Kettles, Nozzles and Jets, Pots and Jars, Pitchers, Retorts, Receivers or Woulff Bottles, Sinks, Storage Jars, etc.
Acid Proof Clay Prod. Co.
General Ceramics Co.
Knight, Maurice A.
U. S. Stoneware Co.

Stopper Heads
Bartley Crucible Co.

Sulphur
Texas Gulf Sulphur Co.
Union Sulphur Co.

Sulphur, Crude
Texas Gulf Sulphur Co.
Union Sulphur Co

Sulphuric Acid Plants
Buffalo Fdry. & Mach. Co.

Supplies, Mill and Mine
Glander & Co.
Jacobowitz, Charles S.
Morse Bros. Mach. & Sup. Co.
Niehoff, Paul & Co., Inc.
Ogden, John
Payne, N. B. & Co.
Perry, Buxton, Doane Co.
Standard Elec. & Elev. Co.
Wickes Mach. Co.

Switchboards
Westinghouse Elec. & Mfg. Co.

Syphons, Acid, Stoneware
U. S. Stoneware Co., The

Tachometers
Schaeffer & Budenberg Mfg. Co.

Tank Cars
Gen'l Amer. Tank Car Co.

Tanks, Acid
Sharpsville Boiler Wks.
Lancaster Iron Wks., Inc.

Tanks, Cast Iron
Buffalo Fdry. & Mach. Co.
Detroit Range Boiler & Steel Barrel Co.

Tanks, Copper
Lummus Co., W. E.

Tanks, Cyanide
Pacific Tank & Pipe Co.
Stearns Lumber Co.

Tanks, Enameled, Acid Proof
Glass Coating Co.

Tanks, Jacketed
Lancaster Iron Wks.

Tanks, Lead Lined, Acid Proof
Amer. Chem. & Sugar Mach. Co.
Hauser-Stander Tank Co.
Johnson & Carlson
New Eng. Tank & Tower Co.
Oakland Copper & Brass Wks.
Stearns Lumber Co.
United Lead Co.

Tanks, Oil
Sharpsville Boiler Wks.

Tanks, Pressure
Lancaster Iron Wks., Inc.

Tanks, Steel
Caldwell, W. E., Co.
Chicago Bridge & Iron Wks.
Coatesville Boiler Wks.
Detroit Range Boiler and Steel Barrel Co.
Janney-Steinmetz Co.
Lancaster Iron Wks.

Tanks or Vats, Stoneware, Acid Proof
General Ceramics Co.
Knight, Maurice A.
U. S. Stoneware Co.

Tanks, Storage
Lancaster Iron Wks.

Tanks, Wood
Atlantic Tank & Barrel Co.
Caldwell, W. E. Co.
Corcoran, Inc., A. J.
Hall & Sons Co., A. H.
Hauser-Stander Tank Co.
Johnson & Carlson
Kalamazoo Tank & Silo Co.
National Tank & Pipe Co.
New Eng. Tank & Tower Co.
Pacific Fdry. Co.
Pacific Tank & Pipe Co.
Stearns Lumber Co.
Wendnagel Co.

Testing Laboratories
See Professional Directory Pages 69-71.

Testing Sieve Shakers
Tyler Co., The W. S.

Thermit
Metal & Thermit Corp.

Thermometers
Bristol Co., The
Precision Therm. & Inst. Co.
Schaeffer & Budenberg Mfg. Co.
Taylor Instrument Co.

Tile Acid Proof
Knight Maurice A.

Titanium
Titanium Alloy Mfg. Co.

Titanium Ores
Titanium Alloy Mfg. Co.

Tongs (Lifting)
Lummus Co., W. E.

Tool Steel
American Stainless Steel Co.
Standard Alloys Co

Tourills; Cellarius, Stoneware, Acid Proof
Knight, Maurice A.

Tower Packing, Acid Proof Stoneware
Knight, Maurice A.
U. S. Stoneware Co.

Towers, Acid
Duriron Co.

Towers, Acid Proof Stoneware
General Ceramics Co.
U. S. Stoneware Co.

Towers, Condensing or Absorbing, Stoneware Acid Proof
Knight, Maurice A.

Towers, Steel
New Eng. Tank & Tower Co.

Towers, Water Cooling
Wheeler Mfg. Co., C. H.

Transformers
Allis-Chalmers Mfg. Co.
American Transformer Co.
Westinghouse Elec. & Mfg. Co.

Transformers, Special and Precipitation Process
American Transformer Co.

Transits
Ainsworth, Wm. & Son

Transmission Machinery, Power
Jones Fdry. & Mach. Co.

Transmission, Silent Chain
Morse Chain Co.

Trucks, Motor
Packard Motor Car Co.

Tubes Brass and Copper, Seamless Drawn
Wheeler Condenser & Engrg. Co.

Tubes, Iron & Steel
Ryerson, Jos. T., & Son

Tungsten Metals
Lavino, E. J. & Co.

Turbo Blowers
Ingersoll-Rand Co.

Turntables, Industrial Ry.
Easton Car & Constr. Co.

Ultra Violet Ray Lamp
R. U. V. Co.

Uranium Alloys
Standard Alloys Co.

Vacuum Pans
Sowers Mfg. Co.

Vacuum Stills
Lummus Co., The W. E.

Valves and Cocks
Merrill Co., The

Valves and Cocks Metal, Acid-Proof
Chemical Equip. Co.
Cleveland Brass Mfg. Co.
Crane Co.
Duriron Co.
Johnson Co., John
Pacific Fdry. Co.
Pratt Eng. & Mach. Co.
Schutte & Koerting Co.
United Lead Co.

Valves and Cocks, Stoneware, Acid Proof
General Ceramics Co.
Knight, Maurice A.
U. S. Stoneware Co.

Valves and Fittings
Colonial Supply Co.

Vanadium Alloys
Colorado Vanadium Co.
Standard Alloys Co.

Vats, Metal, Acid Proof
Duriron Co.

Vats, Wood
Atlantic Tank & Barrel Co.
Hauser-Stander Tank Co.
Johnson & Carlson
New Eng. Tank & Tower Co.
Pacific Tank & Pipe Co.
Wendnagel Co.

Ventilator or Car Cloth
Ludlow-Salyor Wire Co.

Wagon Loaders
Barber-Greene Co.
Jeffrey Mfg. Co., The
Link-Belt Company
Portable Machry. Co.

Washers, Cast Iron
Lummus Co., W. E.

Washers, Chemical
Lummus Co., W. E.

Water Purification, Softening and Rectification
Hungerford & Terry, Inc.
Permutit Co.
Scaife & Sons, W. B.

Welding Materials
Acheson Graphite Co.
Metal & Thermit Corp.

Wire Cloth
Ludlow Saylor Wire Co.
Multi-Metal Co., Inc.
Newark Wire Cloth Co.
Tyler Co., The W. S.

Wood Alcohol Refineries
Lummus Co., The W. E.

Wood Distillation
Apparatus for
Amer. Chem. & Sugar Mach. Co.
Badger E. B. & Sons Co.
Devine Co., J. P.
Zaremba Co.

Wood Distillation Plants
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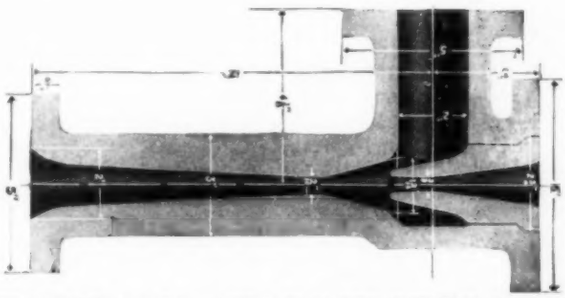

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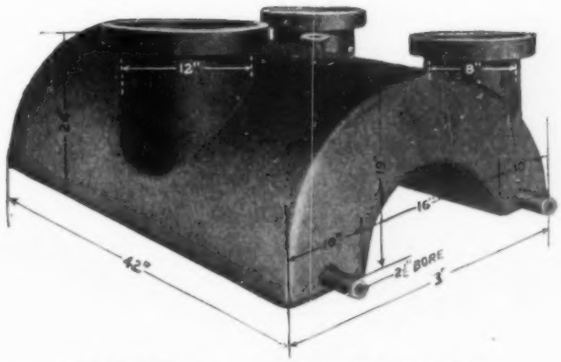

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